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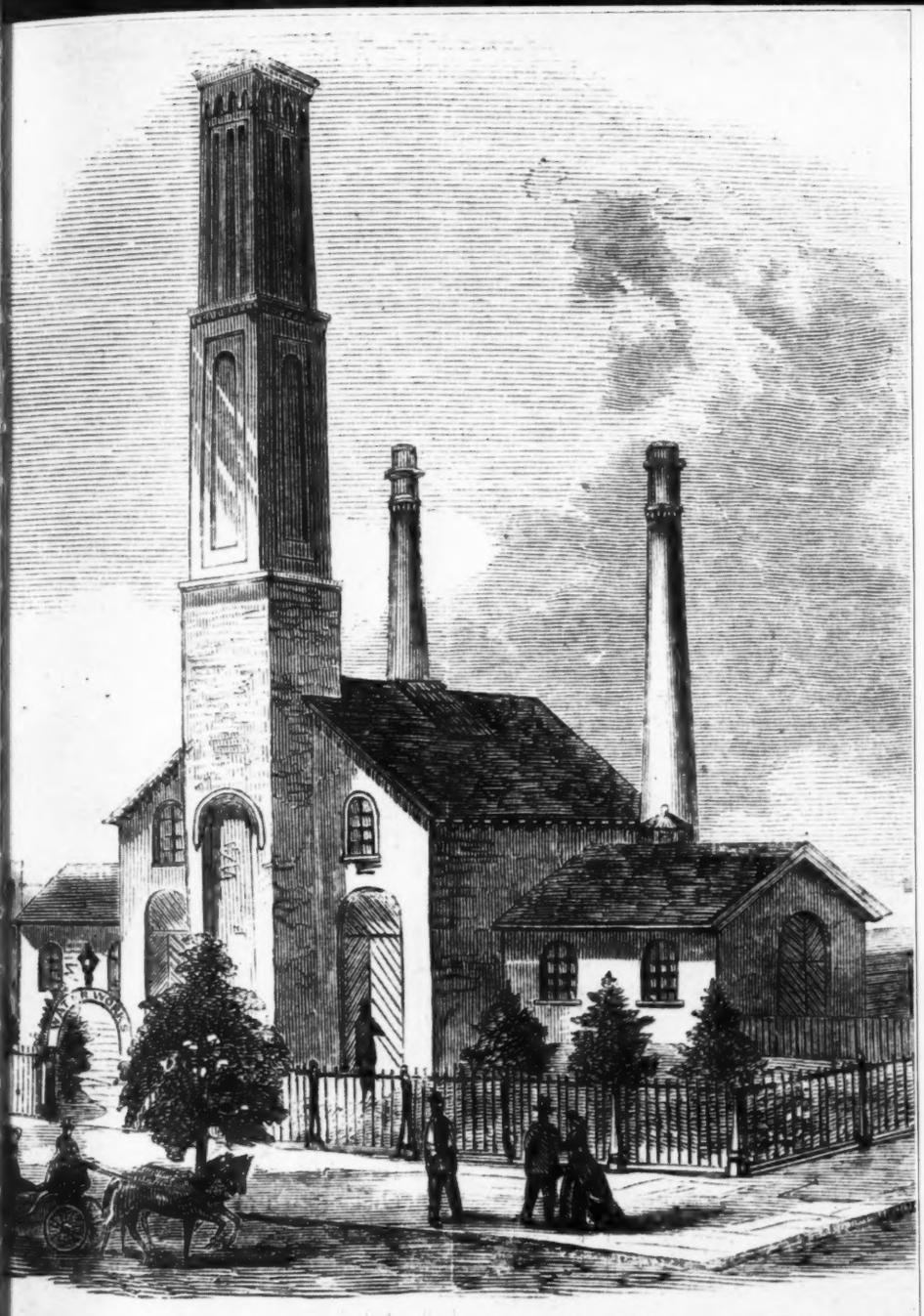

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JUNE, 1933

L. H. Enslow, Editor

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Cast Iron Pipe Trunk Sewers

Hydrant Maintenance

Sewage Chlorination at Downers Grove, Ill.

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Ferric Chloride Treatment at Grand Rapids, Mich.

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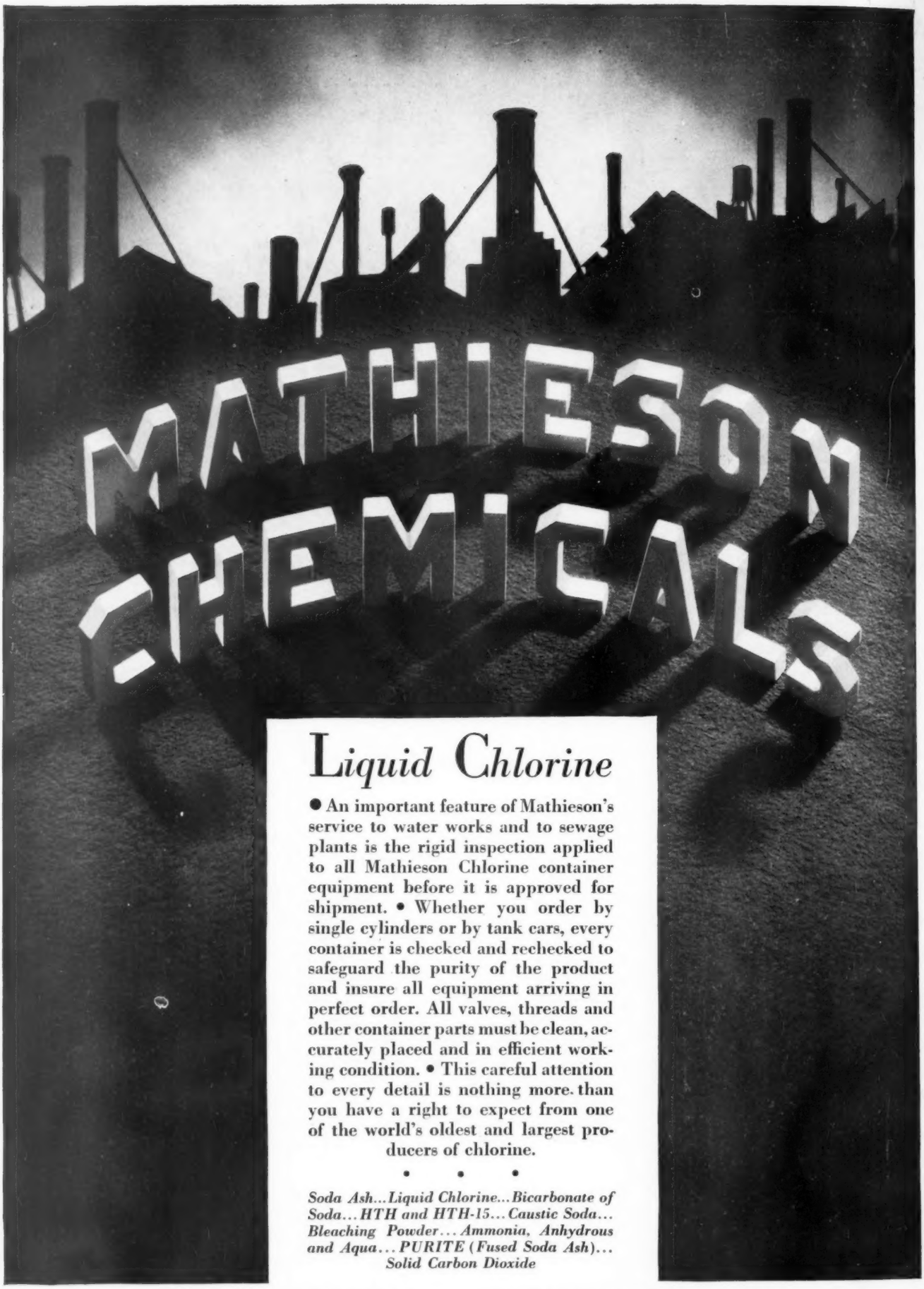

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L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

M. L. Crist, Consulting Engineer, Los Angeles, Calif., discusses "The Proper Administration of Municipally Owned Water Utilities" based on experiences gained in dealing with this problem.

Roger W. Esty, Superintendent of Water Works at Danvers, Mass., will recount interesting and unusual "Experiences in Locating Pipe Lines" with the wireless pipe locator.

Darwin W. Townsend, Principal Assistant Engineer of the Sewerage Commission of Milwaukee, is preparing two articles on "Screenings and Grit Incineration." A description of the new screenings incineration plant at Milwaukee will be presented. Experiences in operation and operating cost data will be revealed in a second article.

C. M. Roos, Manager of the Cairo Water Company, Cairo, Ill., will disclose methods used in "Financing and Operating Water Works During a Depression."

H. H. Hendon, Sanitary Engineer, Jefferson County, Ala., will describe the new "Sewage Treatment Works of Birmingham, Ala.," in which important and well kept cost data are incorporated.

P. S. Wilson, Consultant in Water Works Operation, and formerly with the Community Service Company, will describe practical methods of making flow and pressure tests at fire hydrants and the value of securing such data.

J. S. Strohmeyer, Engineer in Charge of Distribution, Baltimore, Md., will discuss matters of interest to Superintendents of Water Works, in which costs and methods of maintaining water meters and methods of reading and billing, at Baltimore, will be disclosed.

Chas. F. Mebus, Consulting Engineer, Glenside, Pa., will describe the Sewage Treatment Works at Souderton, Pa.

George B. Prindle, Superintendent of Water Works, Highland Park, Ill., writes on the important topic, "Using Perspective in Expenditures for Water Purification."

Vol. LXXX, No. 6

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"The engine-house is of brick in the modern Italian style. In the center of the main building a tower, 14 feet square at the base and 140 feet high, serves as a chimney for the boilers and as a chamber for the standing column; this is a cast-iron pipe, 24 inches in diameter, connected with the pump to serve as a regulator. The engine is about 200 horse-power."—Chicago Tribune, March 18, 1864. The picture is from Harper's Weekly, May 7, 1864.

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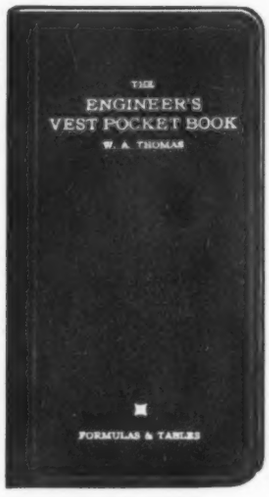

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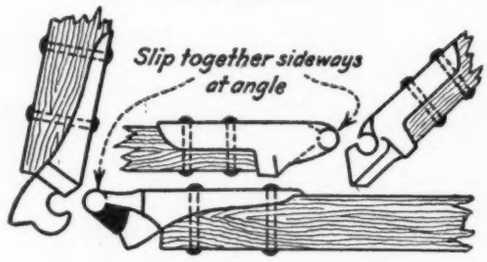

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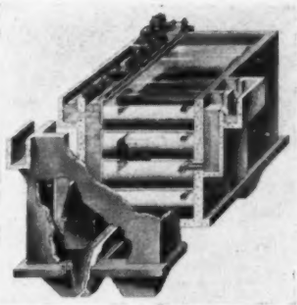

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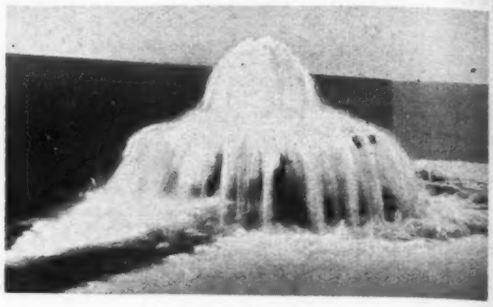

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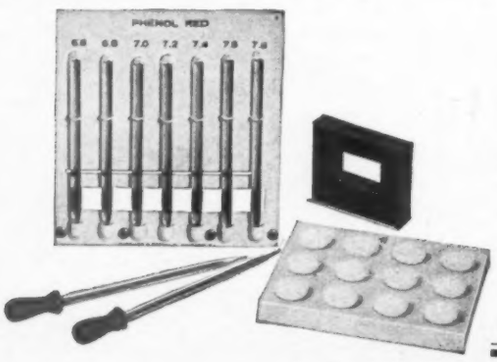

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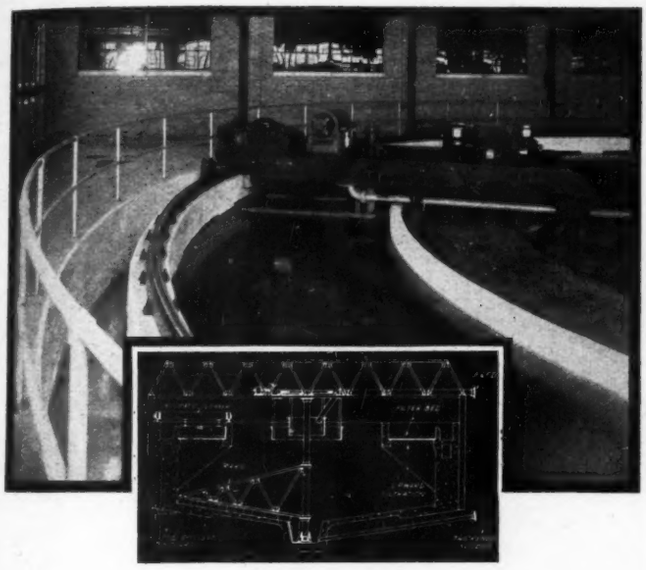

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WATER WORKS AND SEWERAGE
VOL. 80. NO. 6. JUNE 1933
A GILLETTE PUBLICATION

WATER SUPPLY IN RELATION TO CITY AND REGIONAL PLANNING

By MALCOLM PIRNIE

Consulting Engineer of New York City, and President-Elect of the American Water Works Association.

IN one form or another the natural occurrence of water has always been a controlling influence in the location and growth of cities and in the spread of population over the land. The four major influences from a trade and economic standpoint are the following:

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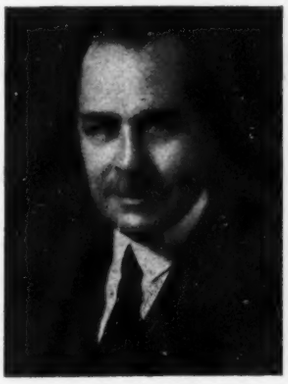
3. The presence of natural waterfalls to which large drainage areas are tributary.
4. The existence of large water courses or bodies of water which have presented barriers to cross-country transportation.



Malcolm Pirnie

The first two elements noted above, harbors and navigable waterways, serve to create port cities. The planning of such cities with relation to waterway improvements, the design and construction of transportation facilities, and the proper location of large industries of a character necessitating location near water transportation provide one element in the relation of water supply to city and regional planning. The other element, no less important, relates to the planning of facilities for providing a satisfactory domestic and industrial water supply, and works for the adequate removal of sewage and industrial wastes from the port areas and from the large suburban developments which necessarily surround them.

The last two elements mentioned above are responsible for the development of many inland centers of population. The earliest manufacturing regions of the country were located in the vicinity of natural waterfalls. More recently similar industrial areas have been created where natural conditions were favorable for the creation of artificial waterfalls through the erection of dams. In other locations cities have grown up around trading centers which were established at points where large rivers or other bodies of water introduced obstructions to cross-country transportation.

In all of the situations discussed above, water has been the prime element responsible for the location and growth of large communities, and also the provision of water for domestic and industrial purposes and as a carrier of waste materials has become one of the great problems of community development.

Until the past two or three decades, most American cities have not had to consider the subject of domestic water supply as a factor influencing their loca-

In connection with graduate courses in Regional and City Planning, the College of Engineering at New York University recently offered, under the direction of Professor Thorndike Saville, a series of ten lectures on regional and city planning by prominent engineers. This article is based upon the context of one of these lectures given by the author.

tion. Such location with regard to water resources has been predicated largely upon navigation, power in industry, and the disposal of waste products. During the beginning of most cities, dug wells and springs have furnished the domestic water. As the community grew, some of the sea coast and a few of the upland cities built impounding reservoirs on inland streams. Most cities which were located on rivers pumped untreated waters into their distribution systems. In a few instances favorable ground-water sources were developed. As a result of lack of knowledge of modern sanitary science, and also to some degree as a result of negligence and carelessness, many river sources and unprotected impounded supplies spread sickness and death, as represented by the many epidemics of water borne diseases which are to be found in the history of sanitation of this and most other countries.

The art and science of developing pure water supplies is relatively recent so far as modern community development is concerned. Little or no thought was given to the subject 50 years and more ago. Even at the present time the proportion of the population not supplied by controlled and adequately protected sources of public water supply is astonishing. Secretary of Labor Perkins has quoted the National Industrial Conference Board as stating that today 30 per cent of the city dwellers have no bathrooms, 90 per cent of rural population have no baths, and 60 per cent of the incorporated towns and villages of the country have no sewerage systems adequate to permit satisfactory bathroom facilities. That such conditions exist must be surprising to many.

Even with a very considerable proportion of the urban population supplied with water which has been subjected to some form of purification, the quality of many public water supplies of the country is susceptible of material improvement in the interest of health, comfort, and convenience. The water supply works now in operation are adequate for not more than half of the present population of the country. It is apparent that a great deal remains to be done, both in making improvements to existing water supplies and in the development of additional water supply facilities for the present population which is unsupplied with such facilities, and for the future population of our cities.

In the past many water supply developments have represented a waste of public funds through lack of careful planning and adequate protection of sources. In numerous instances river supplies which have been developed at considerable expense to the community are now being abandoned in favor of less polluted and more distant sources. Various impounded supplies have become reduced in sanitary quality due to inadequate protection of the drainage area and improper use of land above the impounded water. In addition, many of the distribution mains within the cities themselves have become inadequate to meet the demands of a modern population, or have deteriorated for various reasons, and ought to be replaced by a new and improved system of mains.

Water Works Planning

It should be apparent from what has been said above that water works planning is an integral and necessary part of city and regional planning. Only by making it such can the future needs of the growing community be served at a minimum of public expense and a maximum of public convenience and safety. If zoning has been properly provided for, there will follow logically the possibility of making accurate estimates of future average and maximum demands for water supply. Similarly the proper selection of different districts where water pressures of varying amounts will be necessary can be provided for. The lay-out of the ultimate distribution system can be planned for well in advance of actual construction needs, at great saving of cost. During the developmental period the secondary pipe system contained in the ultimate city plan can be built first. Later this system may be reinforced as necessary with primary feeder pipes and additional supply mains. This will result in a minimum of replacements of the long lived and expensive structures. The distribution and supply main planning and building can be coördinated with the city plan, and the cost minimized by simultaneous construction of the distribution system and supply mains with the extension of the city.

As a matter of fact, planning for water supply should in part dictate the lay-out of portions of a well conceived regional plan. In the first place, since the location of population centers has been influenced by the availability of water, this subject will continue to dictate in some measure as to the development of the environs of the city. In any conception of a regional plan the consideration of occupation of the same rights of way by regional parkways, highways, and water supply mains is important. One important element to which little consideration is usually given is the realization of the necessity for future impounding reservoirs within the region. Adequate sites for such reservoirs should be set aside in the early days of the regional plan. This may be done with due regard to public interest by making of such sites natural recreational areas pending the time when they must be developed for reservoir purposes. After development, provision should be made for the landscaping of these reservoirs and lakes and for providing lake view drives to the more remote natural recreational areas.

Looking Ahead

Methods whereby the expenses of future needed water supply developments may be minimized present one of the most controversial and important questions for the regional planner and the water supply engineer today. In line with the suggestions made in the preceding paragraph as to early restrictions and use of future reservoir sites, the writer believes that the zoning of selected reservoir sites should be provided for in accordance with the best ultimate use. Such zoning would provide among other things for the following:

a. Bottom lands to be used for farming, forests, bridal paths, fishing and camping, or golf courses.
b. Highways, and conforming use structures, should be built above the future flow line of the proposed reservoir and back of an adequate marginal strip to give sanitary protection.

Such a zoning of future selected reservoir sites presents the following advantages:

a. Conserves all future investment for life use.
b. Creates an immediate value for upland high class residential sites which otherwise may be of insignificant value.
c. Continues normal uses and income from bottom lands until needed for reservoir purposes.
d. Conserves all values in the area for best future use.
e. As a result, zoning probably could be effected through agreement with property owners by virtue of resulting early developments which would improve their property.

Much has been heard during recent years to the effect that unreasonable public expenditures have been made on account of the construction of public works far beyond immediate needs. In most instances this is not true, and the present public debt is not due to overbuild-

ing. Insofar as the construction of large water supply and sewerage improvements are concerned they have been planned and fought for by wise public authorities long before construction was actually authorized. In many instances the needs of the community have reached the ultimate service to be provided by the new works by the time they were completed. Delays have been due to general public apathy and to the legal requirements to be met before authorization could be obtained. In normal times the burden of debt for construction of these facilities has not been excessive. However, the method of financing used in the past has unquestionably been wrong in the light of the present emergency. Some consideration of this statement is perhaps in order.

Financing Need Improvement

In the first place, most public improvements have been constructed by the sale of bonds destined to run for thirty or forty years. Forty year bonds cost the taxpayers more than twice as much as ten year bonds in terms of interest payment. On the average the public pays twice for many of its public improvements. It pays once the face value of the bond, and it pays again an equal amount in interest.

Public works construction should be, and in any adequately planned city or region would be, a continuing process. In the future it can be expanded for half what it has cost in the past if it is paid for out of funds currently collected. By improved methods of financing it should be possible to gradually abolish the public debt and to build twice as many public works at the same average cost as has been possible in the past.

The writer has suggested for consideration and discussion a method for improving the financing of public works. A ten year construction budget should be decided upon, and each year as the annual budget is brought in for approval to the governing body there should be contained in this an item allocated to the ten year construction budget. This item would not be expended in one year, but would be used to purchase U. S. Government Bonds. Each year such bonds would be purchased to be held and sold when funds for construction were required in connection with the actual construction work contemplated under the ten year construction budget. Short term serial bonds should be issued only during an emergency or during the period of transition in financing methods from the present and past practice to a new and improved system. The procedure recommended is not legal for many communities at present, which explains the peak of municipal and county debts at the present time. To make the proposed method effective necessary constitutional and statutory changes must be made, and adequate safeguards thrown about the preservation of the annual contributions to the ten year construction budget.

All water supply projects can and ought to be made entirely self-supporting. In the charges to consumers there should be represented a fair price based upon the development cost and the value of service rendered. In addition to these two elements in the water rates there should be an item allocated to providing a portion of the surplus to be placed in the annual construction budget for future use. If this were done, the burden on land would be reduced through selling services at a fair cost to all those who actually benefit. The first claim on water revenue surplus should be for the water works construction and supply funds in the annual ten year construction budget mentioned previously. The second claim on the water revenue surplus should be for general regional and city planning developments which are related to the water works plan. In this way a dual use of areas and work would be provided at minimum cost.

Had the method outlined been followed in the past, the present plan of the Federal Administration to put men back to work would have been much easier to consummate. An emergency, when it happened, would cause the reporting of a zero ten year construction budget. The annual budget would carry no interest and amortization charges which would have to be met from taxation. There would be, however, funds which had been accumulated to meet former construction budgets. It would then be a simple matter for Federal funds to be utilized to match the accumulated funds mentioned and thus reinstate the planned construction work. If this was on a 50-50 basis, there would be no debt created except for the Federal aid, and all sums would be paid directly to local labor for the creation of public wealth. This is believed to be a far better alternative than the dole.

Conclusions

Summing up a conception of the relation of water supply to city and regional planning, the writer has endeavored to emphasize the following points:

1. Most cities have been located with relation to water, and water supply is an integral part of city and regional planning.
2. Great opportunity exists for dual use of rights of way and conserved water supply areas if adequate planning is effected.
3. Planning will minimize losses due to abandonment of water supply works because of inadequate or polluted supplies.
4. The principles of zoning as applied to water supply construction will provide facilities when required at a minimum cost.
5. In support of the pay-as-you-go plan of public works construction the water utility revenue is one of the most important considerations.
6. There exists a tremendous reservoir of planned and needed public works to be speeded up or slowed down as a balance wheel in maintaining employment. This can be accomplished only through new and improved methods of public financing.
7. The important place of water works planning in city and regional planning is self evident. In this lies not only the stabilization in part of work opportunity, but also the improvement of bodily and mental health of all of the people. The proper planning and financing of public works will accelerate evolution in the living standards of our people.

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Supreme Court Orders State of Illinois To Pay for Chicago Sewage Plants

The State of Illinois was ordered by the Supreme Court on May 22nd, to furnish the money necessary to complete the sewage treatment plants of the Chicago Sanitary District by December 31st, 1938, the date effective under the decree issued by the court in April, 1930.

Illinois had pleaded that it was not legally responsible in the circumstances, but the court, in an unanimous opinion by Chief Justice Hughes, rejected this theory as "untenable," and held that Illinois was primarily responsible, because it created and maintained the Sanitary District.

The Supreme Court's ruling brings up an interesting issue, because Governor Horner is quoted as saying he will sign no appropriation bills the Legislature may pass for the purpose indicated. The sum of $139,000,000 is said to be required for completing the sewage plants.

CAST IRON PIPE TRUNK SEWERS IN WASHINGTON SUBURBAN SANITARY DISTRICT

By ROBERT B. MORSE

Chief Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

Robert B. Morse

MANY materials have been widely used for general sewer construction, the engineer's selection in each case being governed principally by size of line combined with a desire to secure durability and economy. While local conditions are often a guiding, and sometimes a controlling, factor, a wise decision does not always prove easy. In the construction of sewers of larger diameter than 24 inches no such consistent practice prevails as in that of small sewers. For sewers above that size, vitrified pipe, to the limit of size available, vitrified segmental blocks, reinforced concrete pipe, and monolithic concrete all have their place in current practice. The protection of interior surfaces of concrete sewers, where disintegration is feared, by complete or partial lining with brick or vitrified liner plates is common.

Speed of construction and smoothness of interior surface have not been given as much weight by sewer designers as they appear to the writer to deserve. Any material which may be placed rapidly and presents slight resistance to the flow of sewage, if it provides a durable, strong, and tight sewer, at not too great a cost for the material itself, naturally will prove advantageous in sewer construction. Cast iron pipe, fulfilling most of the above-mentioned requirements to a marked degree, would appear to offer much promise for use in building sewers, at least those above 24 inches in diameter and where few house connections would occur. That this material has been employed heretofore principally in special types of sewer construction such as submerged outfalls and pressure lines, rather than as a direct competitor of the ordinary materials used in the installation of trunk sewers of moderate size, is undoubtedly due to a widespread belief that the price of the cast iron pipe itself is so high as to result in excessive total cost of finished sewer.

Some interest may attach to a comparison of cost between trunk sewers of reinforced concrete pipe and cast iron pipe with a spun lining of bitumastic enamel. These lines consisted of a considerable length of 30-inch and 36-inch pipe of both types installed in the Washington Suburban Sanitary District before its trunk sewer building program was interrupted as a consequence of prevailing economic conditions.

This district comprises a suburban area of about 102 square miles in Maryland contiguous to the District of Columbia and containing some 65,000 inhabitants. Comprehensive water and sewer systems, consisting of about 300 miles of water mains and 220 miles of sewers, serve the many towns and some of the outlying sections of the area. Their design, construction, and maintenance and operation are under the control of an appointive commission, which issues its own bonds and establishes its own assessments and rates.

The commission, for some years, has done practically all pipe line construction work by its own forces, well equipped at present with necessary machinery for this purpose. Cast iron pipe, when required in large quantities, is purchased under contract, while vitrified and reinforced concrete pipe, cement, and many other materials are usually obtained after receipt of competitive quotations.

Topography and soil in the Washington Suburban Sanitary District vary to a marked degree. The territory, rising from tide-level to an elevation of nearly 500 feet, is mostly rolling or rugged, though extensive areas of low and comparatively flat land exist. Underground conditions are unfavorable, as a rule, for low costs in water main and sewer construction, since rock, caving soil, stiff clay, running sand, and ground-water are frequently encountered.

All of the trunk sewers covered in the following discussion were located in comparatively flat land along streams. The first project consisted of 2,982 feet of 30-inch reinforced concrete pipe, and 4,909 feet of 36-inch sewer of the same material represented the second. The third undertaking, an extension downstream of the above-mentioned 30-inch line, consisted of 3,745 feet of 30-inch, and 5,558 feet of 36-inch, cast iron pipe lined with bitumastic enamel centrifugally applied.

The cast iron pipe used was of the so-called "Hi-Tensile" type with a laying length of 12 ft. 2 in. and a 3-inch depth of bell. Specified thicknesses were 0.70 in. for 30-inch, and 0.82 in. for 36-inch, pipe. Jointing material, practically throughout, for cast iron pipe was mineralead.

The use of cast-iron pipe for trunk sewers represents an innovation in sewer construction. The experiences gained in laying 3,745 feet of 30 inch pipe and 5,558 feet of 36 inch pipe in the Washington Suburban Sanitary District are related in this article.

Based upon such experiences, the author states that a number of miles of sewers of 30 inch diameter and upwards, the construction which is to be started during the coming summer, justifies the continued use of cast-iron pipe under present market conditions—especially when considering the permanency of structure and the several advantages accruing in handling and laying of the pipe.

Conditions affecting the cost of construction may be compared as follows (Table I, Page 193).

All of the sewers were laid below the level of the streams which their courses followed. The difficulties encountered in their construction may be deduced from the information tabulated above.

Unit Costs of Construction

Table II shows for each sewer the cost of construction per lineal foot, excluding only right-of-way costs, engineering, and general

TABLE I

	30-Inch Pipe Sewers		36-Inch Pipe Sewers	
	Reinforced Concrete	Cast Iron	Reinforced Concrete	Cast Iron
Average depth of trench	9.0 ft.	10.0 ft.	10.0 ft.	12.5 ft.
Maximum depth of trench	13.5 ft.	12.5 ft.	14.0 ft.	17.5 ft.
Stream crossings	3 (small)	2	0	1
Cofferdams	0	2	0	1
Paved road crossings	1	0	1	1
Surface	Clear	Clear, part swampy	40% through woods, part swampy	20% through woods
Soil (prevailing)	Loam, gravel, running sand	Loam, gravel, running sand	Loam, gravel, clay	Loam, gravel, running sand
Piling	None	Short section	None	None
Rock	None	None	A few boulders	None
Ground water	Much	Much	Much	Much
Excavation and backfilling	Much by hand	Mostly machine	Mostly machine	Mostly machine
Sheeting	Some tight, rest skeleton	Short sections tight, some skeleton	Short sections tight, considerable skeleton	Some tight, considerable skeleton
Concrete cradle or envelope	Envelope at stream crossings	Envelope at one stream crossing	Considerable low cradle	Envelope at stream crossing
Common labor, rate per hour	40c	45c	45c	45c
Semi-skilled labor, rate per hour	45c	50c	50c	50c
Skilled labor and machine operators, rate per hour	55c to 60c	70c to $1.00	65c to 80c	70c to $1.00
Price of pipe per foot, delivered near job	$2.90	.....	.....	.....
Price of pipe per foot, at local yard	.....	.....	$3.50	.....
Price (average) of lined pipe per foot, on cars	.....	$5.10	.....	$6.80

administrative expenses of the commission. All figures are on a strictly comparable basis from this standpoint. They represent the expense of building the sewers complete, including manholes and other appurtenances.

TABLE II

	30-Inch Pipe Sewers		36-Inch Pipe Sewers	
	Reinforced Concrete	Cast Iron	Reinforced Concrete	Cast Iron
Material	$3.13	$5.24	$4.26	$7.09
Labor	4.08	1.17	3.70	2.30
Machinery (heavy)	0.33	0.52	0.93	0.84
Small tools, equipment, and supplies	0.61	0.18	0.55	0.34
Hauling and transportat'n	0.20	0.25	0.43	0.25
Total	$8.35	$7.36	$9.87	$10.82
Purchase price of pipe	2.90	5.10	3.50	6.80
Total, excluding pipe purchase price	$5.45	$2.26	$6.37	$4.02

As the price per lineal foot for bitumastic lining was $0.70 for 30-inch, and $0.80 for 36-inch, pipe, the total cost per lineal foot for the cast iron sewers, if unlined pipe had been used, would have been $6.66 for the 30-inch, and $10.02 for the 36-inch, size.

Construction work on the cast iron pipe sewers proceeded at a much higher rate of speed than on the reinforced concrete pipe sewers. The following data, Table III, giving the number of days on which a stated number of feet, or more, of sewer was laid, will make this point clear.

TABLE III

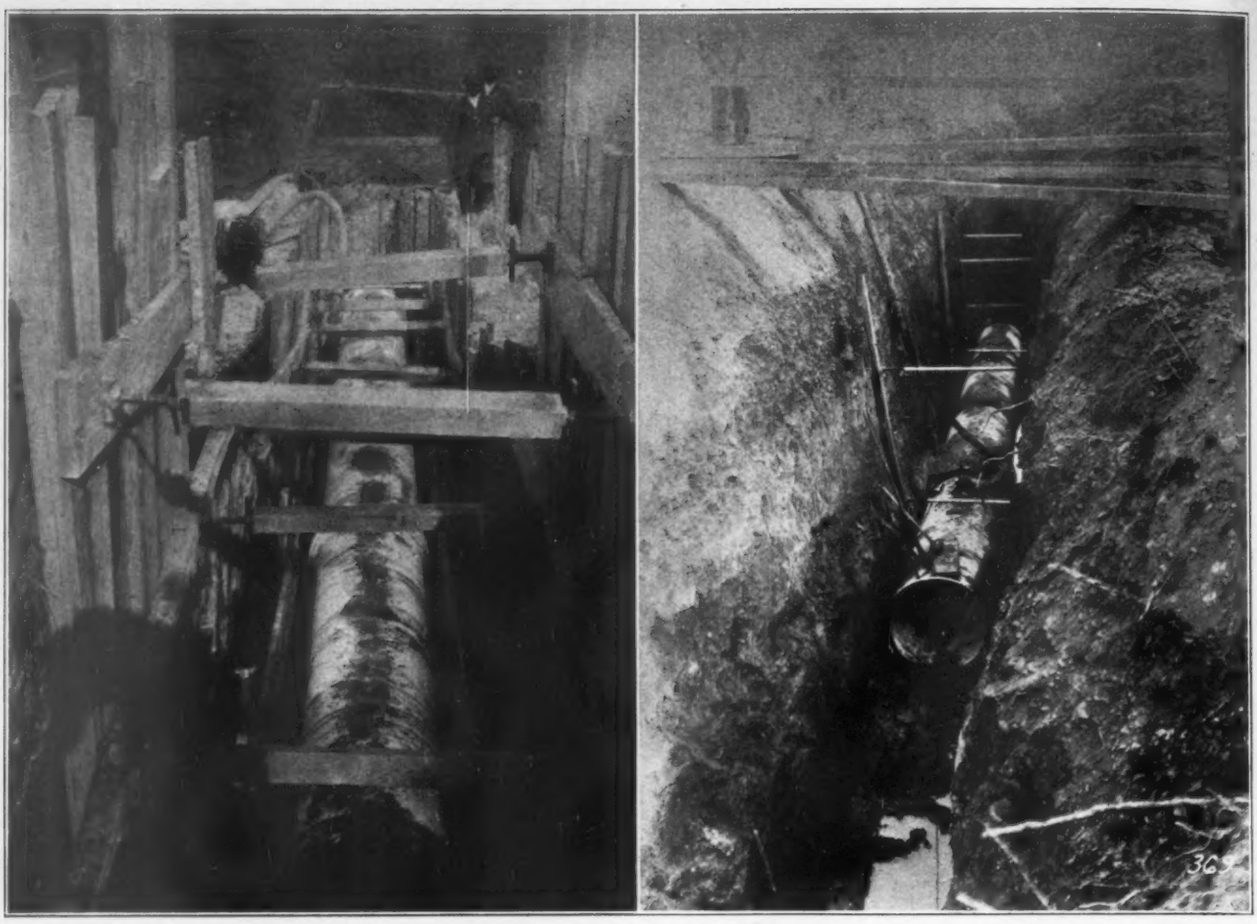
	Days	Ft.	Days	Ft.	Days	Ft.	Days	Ft.	Days	Ft.
30-inch concrete	1	56	4	52	8	48	11	44	35	36
30-inch cast iron	1	365	3	328	7	207	11	110	21	61
36-inch concrete	1	80	4	64	7	60	12	56	37	40
36-inch cast iron	1	194	4	134	7	110	12	97	41	61

All of the projects were carried on largely at a time of year unfavorable for construction work, causing bad trench and difficult hauling conditions, slow progress, interruptions, and considerably higher costs than would have obtained if work had started and proceeded during the normal construction season. Work on the 30-inch reinforced concrete sewer began in late autumn and ended in early spring. Winter weather resulted in frequent interruptions. The 30-inch cast iron line was built in February and March. Construction of both 36-inch sewers started late in the fall and continued with numerous interruptions until pipe-laying was practically completed in June. Work on the 36-inch cast iron pipe line stopped during construction of the 30-inch cast iron sewer, and also, during the spring, for three separate periods totaling about seven weeks, on account of delay in securing satisfactorily lined pipe. Suspension of operations materially increased the cost of the 36-inch cast iron sewer, but just how much it is impossible to determine.

Comparative Conditions Affecting Costs

Commenting briefly upon comparative conditions affecting the cost of the several jobs, average depths of trench were greater for the cast iron than for the reinforced concrete sewers—by over 10 per cent for 30-inch pipe and 25 per cent for 36-inch pipe. Higher labor rates in all classes prevailed in building the 30-inch cast iron line than obtained when the reinforced concrete sewer of the same diameter was laid, and the same was true as to skilled labor in connection with constructing the 36-inch cast iron sewer as compared with the 36-inch reinforced concrete pipe sewer. Cofferdams at stream crossings on the cast iron lines provided another item of extra expense. Underground and hauling conditions, on the other hand, averaged slightly worse for the 36-inch concrete sewer than for the cast iron sewer of equal size. Thick woods, also, impeded progress and the disposition of materials considerably along part of its course. A low concrete cradle of varying height, used on somewhat less than half the length of the 36-inch concrete line, caused additional expense, but this would have been unnecessary had cast iron pipe been laid.

On the 36-inch concrete sewer and on more than half of the cast iron line of the same diameter an old trenching machine was used. Difficulty occurred in keeping this machine on line and it required frequent repair. Progress and economy suffered to some extent on the concrete pipe construction work, but greatly on the work



30-in. Bitumastic Lined Cast Iron Pipe in Place *36-in. Bitumastic Lined Cast Iron Pipe in Place*
Northwest Branch Trunk Sewer, Washington Suburban Sanit ary District, Maryland

connected with the cast iron pipe, where pipe laying was repeatedly delayed on account of inability to make sufficient speed in preparing the trench. The purchase of a new machine aided to a marked degree the work on the remainder of the 36-inch cast iron pipe sewer, and this trencher was used throughout in the installation of the 30-inch cast iron line.

Difficulties with bitumastic lining at the time of installing the cast iron pipe sewers caused numerous short and several long delays, preventing as rapid progress in executing the work as would have obtained otherwise, and adding materially to the cost. These troubles resulted from mistakes at the foundry in connection with the use of primer and flux, damage in shipment, and inability, owing to cold and stormy weather, to coordinate pipe-laying operations with deliveries. Chipping, checking, cracking, blistering, and sagging of the lining caused much concern under highly variable weather conditions, but practice has improved materially and bitumastic-lined pipe received more recently for water line construction has occasioned little trouble. The early rather unsatisfactory experience with lined pipe has not caused the writer to question its great value in both sewerage and water works construction. In those places where large quantities of cast iron pipe are used, possible difficulties may be avoided and economy result by installing apparatus locally for lining pipe centrifugally with bitumastic enamel as construction operations require. Equipment for this purpose involves a remarkably small investment. The Washington Suburban Sanitary District has recently arranged to line cast iron pipe in this manner at its own yard.

It will be noted that the 30-inch reinforced concrete pipe sewer cost nearly 13.5 per cent more per lineal foot than the one built of cast iron pipe, and that the 36-inch cast iron line cost 9.6 per cent in excess of the reinforced concrete pipe line. It is worthy of comment, also, that pipe alone, for the concrete jobs, represented approximately 35 per cent of the total cost of the work, while the purchase price of the 36-inch bitumastic lined cast iron pipe was about 63, and of the 30-inch pipe about 70, per cent of the expense involved in the respective construction projects.

Without making any allowance for the extra expense caused by difficulty experienced with unsatisfactory bitumastic lining, and deducting only the purchase price of the lining itself, we find that the 30-inch reinforced concrete pipe sewer cost over 25 per cent more than the 30-inch cast iron sewer would have cost if unlined pipe had been used, and that, without lining, the 36-inch cast iron pipe sewer could have been laid at a cost only 1.5 per cent in excess of that obtaining for the 36-inch concrete sewer. The purchase price of the 30-inch unlined cast iron pipe represented approximately two-thirds, and of the 36-inch pipe three-fifths, of what the respective jobs would have cost.

The high cost of labor and correspondingly low figure for machinery, together with the slow rate of progress, in connection with the 30-inch concrete sewer project was due largely to the use of a crane-operated clam-shell bucket, and to a large extent hand labor, on excavation and backfilling. One must bear this in mind when comparing the cost of this line with that consisting of cast iron pipe of the same diameter. It is clear, nevertheless, that expenditures for labor are decidedly lower when

cast iron pipe is used, and they may become exceedingly small under favorable conditions.

Though a general statement on the subject may appear highly controversial, experience gained from the construction work under discussion indicates that cast iron pipe sewers—at least those of moderate size—can be built, under similar conditions, perhaps nearly twice as fast as reinforced concrete pipe sewers of the same diameter, unless trench conditions are such as to obstruct materially the progress of handling and laying pipe. Three pieces of concrete pipe in 4-foot lengths must be swung into the trench, lined up, and jointed to every one of cast iron. Ordinarily trenches may be slightly narrower for cast iron pipe, and as laying proceeds at a more rapid rate and as trenches need not stay open so long a smaller amount of sheeting for the prevention of caving is often necessary. Cast iron pipe may be purchased in lengths of four, six, and eight feet, for use where trench bracing interferes with the placing of longer lengths; but speed and economy of construction are correspondingly reduced. In the projects above described, progress of construction on the cast iron pipe sewers, as a general rule, was governed by the speed that could be made by the trenching machine, while on the 36-inch concrete pipe line the rate of pipe handling and laying usually controlled the progress secured, the trenching machinery remaining intermittently idle.

After a careful consideration of all the conditions obtaining in connection with the above-mentioned undertakings, and evaluating them as far as possible, the writer believes that, at least under ordinary circumstances in open country and with the usual relative prices for pipe, bitumastic-lined cast iron pipe sewers of moderate size can be constructed at but little, if any, greater cost than reinforced concrete pipe sewers of the same diameter and laid at equal depth; and that unlined cast iron pipe sewers will often prove somewhat lower in cost under the same conditions. At any rate, cast iron pipe deserves to be considered in competition with other materials for trunk sewer construction, even from the standpoint of cost, except where local conditions seem to be particularly unfavorable. In addition to presenting a reasonable probability, under many conditions, of proving a competitor in cost of construction, cast iron pipe will provide a sewer absolutely watertight except at manholes, and one of unquestionable durability.

The writer will not discuss here the comparative strength of reinforced concrete pipe and cast iron pipe. Let it suffice to say that even "Hi-Tensile" cast iron pipe manufactured for a head of 100-feet is stronger than the specified requirements for either "standard" or "extra strength" reinforced concrete pipe of equal diameter, and consequently its use will require a supporting cradle less frequently in deep sewer trenches.

Comparative Carrying Capacities of Sewers

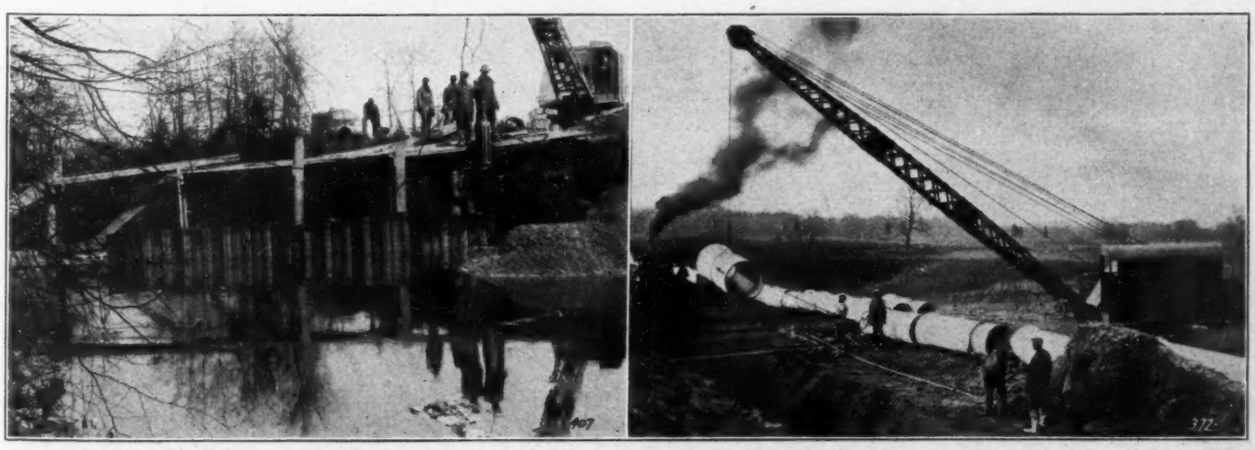
Thus far we have considered a cast iron pipe sewer and a reinforced concrete pipe sewer on the basis of equal diameters and equal depths. If, however, the cast iron pipe sewer has a line of bitumastic enamel, centrifugally placed, it will have a larger carrying capacity than a reinforced concrete pipe or other type of sewer laid to the same gradient; and to obtain the same capacity the cast iron pipe would be laid on a flatter slope.

Though tests indicate the conservative use of a value of 150 for "c" in the Hazen-Williams formula for a cast iron pipe line with a spun lining of bitumastic enamel, when carrying clean water, the writer considers it unsafe at this time to count on a value in excess of 140 for a sewer built of this material, on account of the slime which will adhere to the interior surface.

For reinforced concrete sewers built with pipe in 4-foot lengths the writer believes a value of not over 120 for "c" can be consistently maintained, and 110 is more conservative for ordinary concrete sewer construction.

The 30-inch bitumastic lined cast iron pipe sewer under discussion was laid on a slope of 4.9 feet per thousand, and the slope of the 36-inch cast iron line averaged 3.08 feet per thousand. Using a value of $c = 140$, the 30-inch sewer, flowing full, would have a carrying capacity of approximately 24.7 Mgd, and the 36-inch line one of 31.0 Mgd. To obtain the same capacity a 30-inch concrete sewer, with $c = 120$, would have been 6 feet deeper at the lower end than the cast iron line is; and with $c = 110$ the additional depth would be 10.5 feet as a maximum. Corresponding figures for a 36-inch concrete sewer, compared with the 36-inch cast iron sewer actually constructed, would be approximately 5.5 and 9.6 feet respectively. With $n = 0.013$ in Kutter's formula, a value commonly used for concrete sewers, the slopes required for 30 and 36-inch reinforced concrete pipe sewers, to take the place of the cast iron lines installed, would have been slightly greater even than those required with $c = 110$; and with $n = 0.012$, also used for concrete sewers, a similar statement holds as compared with the slopes required with $c = 120$.

If 30-inch and 36-inch reinforced concrete pipe sewers, laid on the same gradients, had taken the place of the cast iron lines installed, they would have a full carrying capacity of only about 21.1 Mgd and 26.6 Mgd, respectively, on the basis of $c = 120$, instead of 24.7 Mgd and 31.0 Mgd expected of attainment with the lined



Cofferdam on 30-in. Cast Iron Pipe Sewer Line *36-in. Bitumastic Lined Cast Iron Pipe Being Lowered in Trench*

Northwest Branch Trunk Sewer, Washington Suburban Sanitary District, Maryland

30-inch and 36-inch cast iron sewers; and, with c = 110, the capacity of the 30-inch and 36-inch concrete pipe lines would fall to approximately 19.4 Mgd and 24.4 Mgd, respectively.

It is evident that smoothness of interior surface offers a striking advantage in economy of construction for sewers of considerable length, due to the possibility of using flatter slopes for securing necessary capacity with a line of given diameter. To have laid, for example, the 3,745 feet of 30-inch and the 5,558 feet of 36-inch sewer, at average increased depths of 3 feet and 2.75 feet, respectively, as the substitution of reinforced concrete pipe (with c = 120) for lined cast iron pipe would have required, would have entailed great additional expense, particularly with the bad underground conditions obtaining. In order to maintain average depths of trench no greater than those obtaining with the 30-inch and 36-inch cast iron sewers, while providing the same capacity, the first section would have required replacement by a line composed about one-third of 30-inch, and two-thirds of 33-inch, reinforced concrete pipe; and the second section by one of less than one-fourth 36-inch, and more than three-fourths 39-inch, reinforced concrete pipe. This arrangement, also, would have resulted in an increased cost.

After a thorough consideration of the probable underground conditions to be met along the line of the proposed sewers, and a comparison of gradients and sizes necessary with different materials, the writer determined upon the use of cast iron pipe with a bitumastic lining centrifugally placed. He realized the advantage this material would offer in obtaining a water-tight line under the existing high ground-water level, felt sure of the increased rate of construction progress possible and the lower labor expenditure necessary, and believed that these factors might produce a finished sewer of no greater total cost than one built of other materials. It seems that this belief was justified.

A number of miles of trunk sewers 30 inches and upwards in diameter must be built in the Washington Suburban Sanitary District in the near future. Some of this construction work will start during the present summer. These lines will follow generally the courses of streams, mostly in relatively open country, and some of them will lie below tide level. The generally satisfactory experience with lined cast iron pipe in connection with the sewers already installed will result in the certainty of its use for the extensions planned this year, and in the probability of continuing with this material on future similar work if the cast iron pipe market does not advance out of proportion to that for other materials, or unless there becomes available, at a competing purchase price, a strong, durable, and smooth pipe in at least 12-foot lengths, weighing certainly not appreciably more than cast iron pipe, so that equal speed and at least equal economy of construction may be secured.

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Fertilizer Production at Milwaukee Sewage Disposal Plant.—During 1932 the activated sludge plant of Milwaukee, Wis., treated an average of 78.98 million gallons of sewage per day, removed 98 per cent of the bacteria, and 92 per cent of the suspended solids. It produced a total of 31,515 tons of Milorganite, of which 52 per cent was shipped to fertilizer manufacturers and 48 per cent to special markets such as golf courses, parks, greenhouses, home owners, etc., where it was used directly, without the admixture of any other materials.

Purification of Beet Sugar Factory Effluents

The British Department of Scientific and Industrial Research, London, England, has issued as Water Pollution Research Technical Paper No. 3, the details and the results of an intensive investigation on the purification of waste waters from beet sugar factories which has been in progress for some years.

As a result of the first part of their inquiry, the Water Pollution Research Board concluded that the problem could be largely and in many cases completely solved by modifications in the factory processes and by simple methods of treatment of the waste waters such that the waters could be re-used in the factory. This conclusion and suggestions for the re-use of the waters were at once communicated to the industry.

It was appreciated, however, that before the maximum re-use of water could be achieved by the industry as a whole, a certain amount of reorganization in a number of the factories would be required. There was also the possibility that even after reorganization it might be necessary on occasion to discharge a proportion of the waste waters. Further, some factories may prefer, for various reasons, to purify the wastes sufficiently to allow of their discharge into the river, rather than to re-use the waters. After preliminary laboratory experiments at the Rothamsted Experimental Station, the Water Pollution Research Board concluded that, as a method of purification, the process of biological oxidation on percolating filters showed promise of success. This process is similar to that in use at many sewage disposal works. The investigation was accordingly extended to include semi-commercial scale experiments on the method of biological filtration.

The report shows that a high degree of purification, of the order of 90 per cent for press water, the most polluting of the factory effluents, can be attained by the process of biological oxidation on percolating filters. At the same time the conditions necessary for this high degree of purification have been ascertained. Treatment of the effluents by oxidation on percolating filters was systematically studied not only in its chemical but also its biological aspects. The organisms present in the filters included bacteria, fungi, yeasts, algae, protozoa, rotifers, nematodes, insect larvae and oligochaetes. Many hundreds of strains of bacteria were isolated for physiological study in the laboratory, and the investigation in this direction has been one of the most thorough of its kind.

The report is published by H. M. Stationery Office, London, England; price, $1.80.

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Milwaukee Makes Temporary Reduction in Water Rates.—According to the 1932 report of the Common Council of Milwaukee, Wis., the city made a temporary voluntary emergency reduction of 1 ct. per 100 cu. ft. in its schedule of metered water rates. This was done in view of the unusual economic conditions prevailing and with the approval of the Public Service Commission of Wisconsin. The rate to consumers inside of the city was reduced from 7 ct. to 6 ct. and to consumers outside of the city from 10 ct. to 9 ct. This emergency rate is to be in effect for one year, after which the old schedule will be reinstated unless previously altered or amended on petition of the utility or its customers, or on motion of the Public Service Commission. The expiration of the temporary period will be on and after July 1, 1933, in the first district, August 1, 1933, in the second district, and September 1, 1933, in the third district. This was found necessary as all water rates are not due and payable at the

HYDRANT MAINTENANCE

By E. T. CRANCH
Manager-Superintendent, New Rochelle Water Co., New Rochelle, N. Y.

Eugene T. Cranch

THE fire hydrants of any water works are perhaps the least used of any part of its equipment. They are subject to the greatest abuse. Yet if they are not ready for immediate use at all times the management of the water works is held strictly accountable. If one hydrant out of thousands fails to function when needed that is news, the newspapers will broadcast it, and everyone in the community will know of it. The water works management will be condemned from all sides. Any number of hydrants may function perfectly year after year, but that is only what is to be expected and there is no news value in that fact.

With many water works hydrant maintenance is considered a matter of but little importance and is done only when the men have some spare time. If the season happens to be particularly busy hydrant maintenance is omitted.

In addition to the necessity of having every hydrant ready to function on a moments notice, it must be remembered that a fire hydrant is the only part of a water works system that the ordinary citizen sees. He is therefore inclined to judge the water works by the appearance of the hydrants. If the hydrants are rusted and neglected, the impression is all too frequently made on the general public that the management of the water works is lax and inefficient. Whereas if the hydrants are maintained so that their appearance is always neat and attractive the water works management is generally given credit for being on its toes.

In order that hydrants may be properly maintained, it is imperative that each hydrant lateral be equipped with a gate. Such a gate should not be set too close to the base of the hydrant. When possible the gate should not be less than 5 feet away from the hydrant. Sometimes when a hydrant is broken a geyser will develop and if the gate is too close it may be impossible to reach it and it then becomes necessary to close down the main which not only causes a serious delay but is a great inconvenience to the public. With the newer models of practically any make of hydrant there should be no geyser when it is broken but sometimes, due to the condition of the ground in which the hydrant is set, it will break off at the lateral when hit, then no matter what kind of a hydrant is used there will be a flood.

Fortunately in New Rochelle practically all the hydrants were equipped with gates on the laterals when installed. In 1928 a detailed survey was made of every hydrant and gates were immediately installed on all such laterals as were not already so equipped.

One man has been assigned the duty of routine hydrant maintenance. He has been furnished with a ¾-ton panel delivery truck which carries the complete equipment of a small machine shop. This is illustrated in Fig. 1. Each hydrant is carefully inspected twice a year. The hydrant is first gently flushed in order to clear the lateral but care is taken not to rile the water in the mains. This first operation is illustrated in Fig. 2. The pressure on the hydrant is then taken with a carefully calibrated test gauge and a record made of the pressure. It is noted whether the drip operates properly both on opening and closing the hydrant. The packing is inspected and the threads of each cap cleaned and greased. Some time ago we decided that chains on the caps were only an unnecessary nuisance so that they have all been removed much to the satisfaction of the fire department. Our previous experience proved that all too frequently the chains would stick or catch much to the annoyance of the firemen with the result that the chains were continually being broken. When the chains were first removed it was thought that caps might be lost during a fire so each truck of the fire department was equipped with two extra caps, one for a steamer nozzle and one

Methods of Protecting Hydrants

Fig. 1.—Hydrant Maintenance Truck of New Rochelle Water Co., New Rochelle

Fig. 2 (Upper)—Hydrant Is First Opened to Give Gentle Flushing.

Fig. 3 (Lower) Stem and Gate Valve Are Next Removed for Inspection

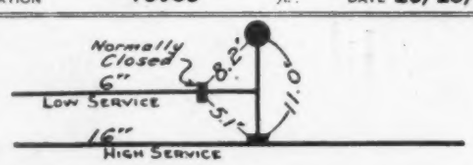
for a hose nozzle. However, in the several years that we have now operated without chains there has not been a single one of these extra caps used to our knowledge.

This year we are also removing the stem and gate from each hydrant for inspection, as illustrated in Fig. 3. This is being done for the reason that we have found in many instances that although the hydrant and drip will appear to operate in a satisfactory manner on removing the stem we found that the gate and drip rubbers frequently needed to be replaced. We do not, however, expect it will be necessary to follow out this last operation on every hydrant each year.

As each hydrant is inspected in the spring, it is given a fresh coat of paint. For this purpose we use a special yellow hydrant paint which, while it withstands the weather in excellent shape, does not produce such a high gloss that it is difficult to spread another coat the following year. The top of the hydrant and the caps are painted with aluminum. This combination gives the hydrant an attractive appearance and a high degree of visibility both day and night and summer and winter. With this annual painting it will undoubtedly be necessary some time in the future to remove the old paint by scraping but from present indications such an operation will not be necessary for many years to come. With this annual coat of fresh paint, the hydrants at all times indicate that they are being well kept.

Guion Place corner Sickles Avenue No. 280

SIZE OF LATERAL	6"	LENGTH	18.0	ft.	
DISTANCE HYDRANT TO GATE			11.0	ft.	
MAKE	Ludlow		OPENS	R.	
SIZE OF VALVE OPENING			4	in.	
DATE SET	1904	Re-set 9/27/29			
MOVED			DATE		
MOVED			DATE		
SIZE OF MAIN	16-inch	(also connected to 6" main. See sketch.			
ELEVATION	75.85	ft.	DATE	10/15/30	



PRESS.	DATE	INSPECTED	PRESSURE	DATE	INSPECTED
88	10/23/20				
33	11/5/23	11/8/23			
38	11/3/24	4/9/24			
40	8/19/25	same			
94	9/26/29	same			
95	3/7/30	same			
104	7/31/30	same			
98	10/31/31	same			
100	3/26/32	same			
100	8/5/32	same			
101	3/17/33	same			

Guion Place corner Sickles Avenue No. 280

Fig. 4—Card for Recording History, Description and Unusual Features of Hydrants

Hydrant Protection

In common with all water works we have hydrants broken by automobiles and trucks. When we find a hydrant is subjected to repeated damage we endeavor to protect it in some such way as illustrated in Fig. 4. Posts are made of short lengths of 8 inch pipe imbedded in the ground and filled with concrete. In one picture it can be seen where one of the posts has been hit by a car since it was installed. The picture on a residential corner illustrates a hydrant located at a particularly bad corner. The hydrant was broken three times in the course of a few months. We first put posts up at this hydrant but the owner of the house immediately back of the hydrant raised very strenuous objections to them, claiming that the posts ruined the appearance of the property. A compromise was finally reached by placing large boulders around the hydrant, as illustrated. Since placing these stones two cars have been driven up on them but the hydrant has not as yet been damaged.

Finally a Kardex file is kept of all hydrants. A reproduction of this card is shown on Fig. 5. These cards are filed alphabetically, first as to municipalities and then as to street location. This card gives a complete history and description of the hydrant and any unusual features relative to the setting are shown on a sketch as indicated.

We have explained above our routine method of hydrant maintenance, whereby every hydrant is inspected twice a year. In addition to this after every fire each hydrant used in such fire is inspected. We have two objectives always before us in hydrant maintenance, namely, to keep all the hydrants neat and attractive in appearance, and last, but after all most important, to keep every hydrant in such condition that it is capable of operating smoothly and to full capacity on a moment's notice at any hour of the day or night, summer or winter.

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Water Clocks

An Early English Water Clock. Note Drip Spigot at Bottom of Water Tank.

Courtesy of Copper and Brass Research Assn.

"JOHN, have you watered the clock?"

This did not sound at all ridiculous when a Seventeenth Century English housewife asked this question of her husband. And some such thing was probably also said in Latin to slaves in Roman homes many centuries before.

Water clocks, which clock collectors love to call "Clepsydrae," were perhaps the earliest kind of clock known and were used since the dawn of history until a little more than two centuries ago, when they went out of fashion.

Most people nowadays never heard of a water clock—illustrating that one age frequently is ignorant of the commonplace things of another. Collectors, however, prize water clocks and the old specimens are in very good condition, in fact many of them are still serviceable. Water clocks were made of copper, brass or bronze, and because they naturally were continually exposed to moisture the use of corrosion resistant metals was necessary.

Water clocks were known to be used by the ancients in Egypt, Babylonia, Chaldea and Judea. The early mechanism was very simple, yet might well be called a proper clock because it kept fairly accurate time. One of the earliest types consisted of a copper basin filled with water which trickled drop by drop, at a predetermined rate, from a spout or tap into another receptacle which had on its inside marks for indicating the hours. One could peck the lower cup and notice if the level of the water was at a line denoting such and such an hour.

In India there was even an alarm variety of water clock. The Indian clock consisted merely of a copper bowl having a very small hole in the bottom. The bowl was placed in a larger vessel containing water, wherein it floated initially, but gradually filled because of the water running in through the hole in the bottom. The bowl naturally sunk at the expiration of a more or less uniform period of time. Seated near the bowl was a boy who acted as the alarm attachment. It was his business to watch the sinking bowl and when it was completely submerged he would strike a gong and thus announce the passing of a period of time, which in the Brahmin's reckoning was about 45 minutes. The Egyptians had a well developed water clock mechanism about 300 B. C. and from that time on through the Seventeenth Century the water clock in Europe was a more or less common method of reckoning time.

These water clocks, generally speaking, had deep and narrow tanks, above which the face, with one hand was located. Some of the early ones, however, had an upright indicator like a thermometer, instead of a dial. In the tank there was a float to which was attached a rod extending up to the dial or to the perpendicular indicator as the case might be. In some of the clocks the water escaped from the bottom of the tank through a small spigot with a minute opening. (See illustration). Naturally as the water receded the float sank and the rod, connected with a simple mechanism behind the face, moved the hand of the clock. In other types the process was reversed. The water was allowed to fall into the tank drop by drop from a container above and this raised the float which pushed a notched rod up against a cog wheel. The working parts were made of brass or bronze.

The clepsydra was introduced into Rome about 150 B. C. It was not only used for domestic timekeeping but to keep a check on Roman orators when they were limited to certain periods for their discourses in the Forum or in courts of law. In the days of the Decline, it is said, enemies often tampered with the water clocks so as to cheat an orator out of his full time.

The old Roman water clocks had a face with twelve hours marked in Roman numerals and it is curious that we moderns have stuck to this same face with old Roman numerals.

Water clocks were not generally used in England until the latter part of the Seventeenth Century when they became popular, and there are some very fine specimens in clock collections.

Acknowledgment:—The information used in the preparation of this article was supplied by Mr. Timothy G. Turner, Copper and Brass Association, Los Angeles, Calif., as was the cut showing the water clock in the collection of Mr. John G. Bullock of Los Angeles.

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OREGON ENGINEERS ASK SEWERAGE SURVEY.—Creation of a commission or board of qualified engineers to act under the direction of the governor's committee on state projects to make a survey of costs and methods of sewerage disposal for the cities in the Williamette River watershed is proposed by the engineers of Oregon.

CHLORINATION AT DOWNERS GROVE, Ill. HELPS SOLVE SEWAGE WORKS ODOR AND STREAM POLLUTION PROBLEMS

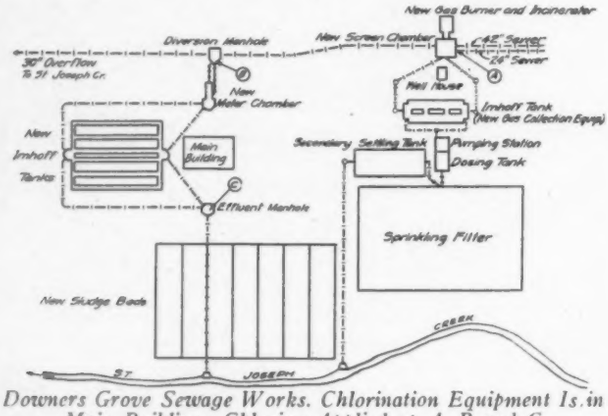
By HARRY F. FERGUSON and W. HOMER WISELY

Respectively Chief Sanitary Engineer and Assistant Sanitary Engineer, Illinois Department of Public Health

AN increase in population of the Downers Grove Sanitary District from 3,500, when it was organized in 1921, to nearly 12,000 in about 6 years made the sewage-treatment works, which was built and placed in operation in 1922, very inadequate and resulted in very objectionable pollution of St. Joseph Creek with many complaints of odors by property owners for several miles downstream. Also the development of a residential district near the sewage treatment works resulted in strenuous complaints because of the odors.

H. F. Ferguson

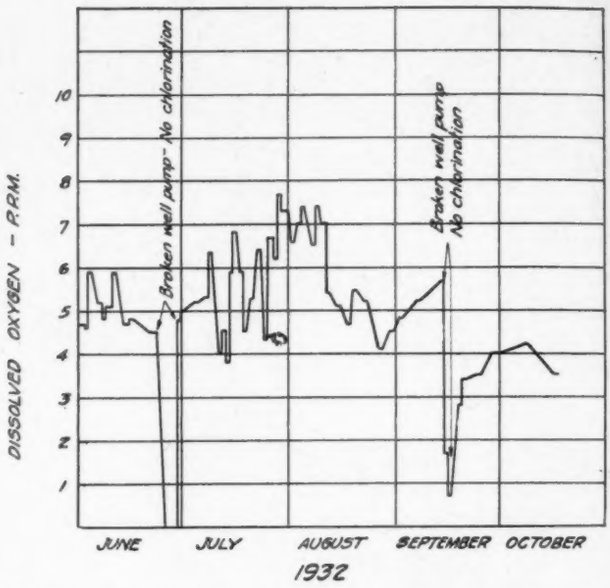
One project considered was the construction of a new plant, large enough to handle the increased population,



Downers Grove Sewage Works. Chlorination Equipment Is in Main Building; Chlorine Applied at A, B and C

at a site considerably farther downstream and more remote from residences. The possible abandonment of the sewage-treatment works that had been in service for only 6 years and had been financed by issuance of 10-year bonds naturally brought strenuous objection from the taxpayers. Also objections arose because it was considered that the proposed new site would be as critical with further residential development. Downers Grove and surrounding territory are suburban residential areas, many of the people being employed in Chicago. The railroad furnishing transportation to Chicago parallels St. Joseph Creek. Residential development naturally will be along the railroad and thus will border the creek for several miles downstream and to the west of the village of Downers Grove.

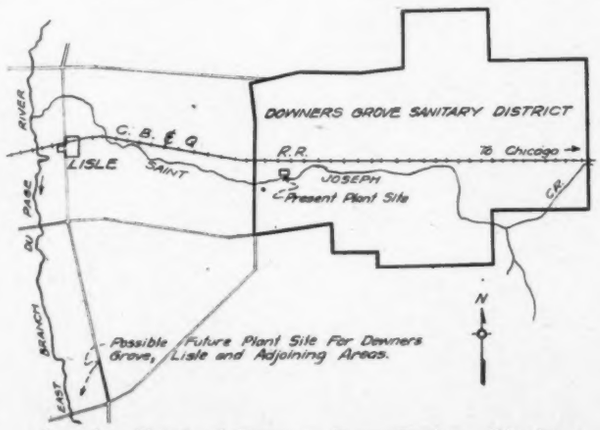
Engineering studies by W. T. McClenahan and A. L. Tholin indicated that when the territory downstream from Downers Grove toward Lisle became built up the logical plan would be to have an intercepting sewer along



Dissolved Oxygen in St. Joseph Creek ¼ Mile Below Sewage Works at Downers Grove, Ill.

St. Joseph Creek to Lisle and then south along East Branch of DuPage River to a suitable sewage works site, bringing it the sewage from the existing Downers Grove sewage works by a southwest outlet sewer. Consequently it was felt that any expenditures at the existing or any other site on St. Joseph Creek should be kept at a minimum but at the same time should correct the sewage works and stream odors which were the cause of the complaints.

The engineers recommended the installation of additional sedimentation units at the existing sewage-treatment works and provision for chlorination of all the sewage. The part of the sewage going to the original tank and filter units would be chlorinated to reduce its strength and thus permit heavier volume loading of the filters and



Location Sketch of Downers Grove Sanitary District

Downers Grove Sewage Works. Battery of Chlorinators. Chlorine Cylinders and Platform Scales in Room on Other Side of Wall

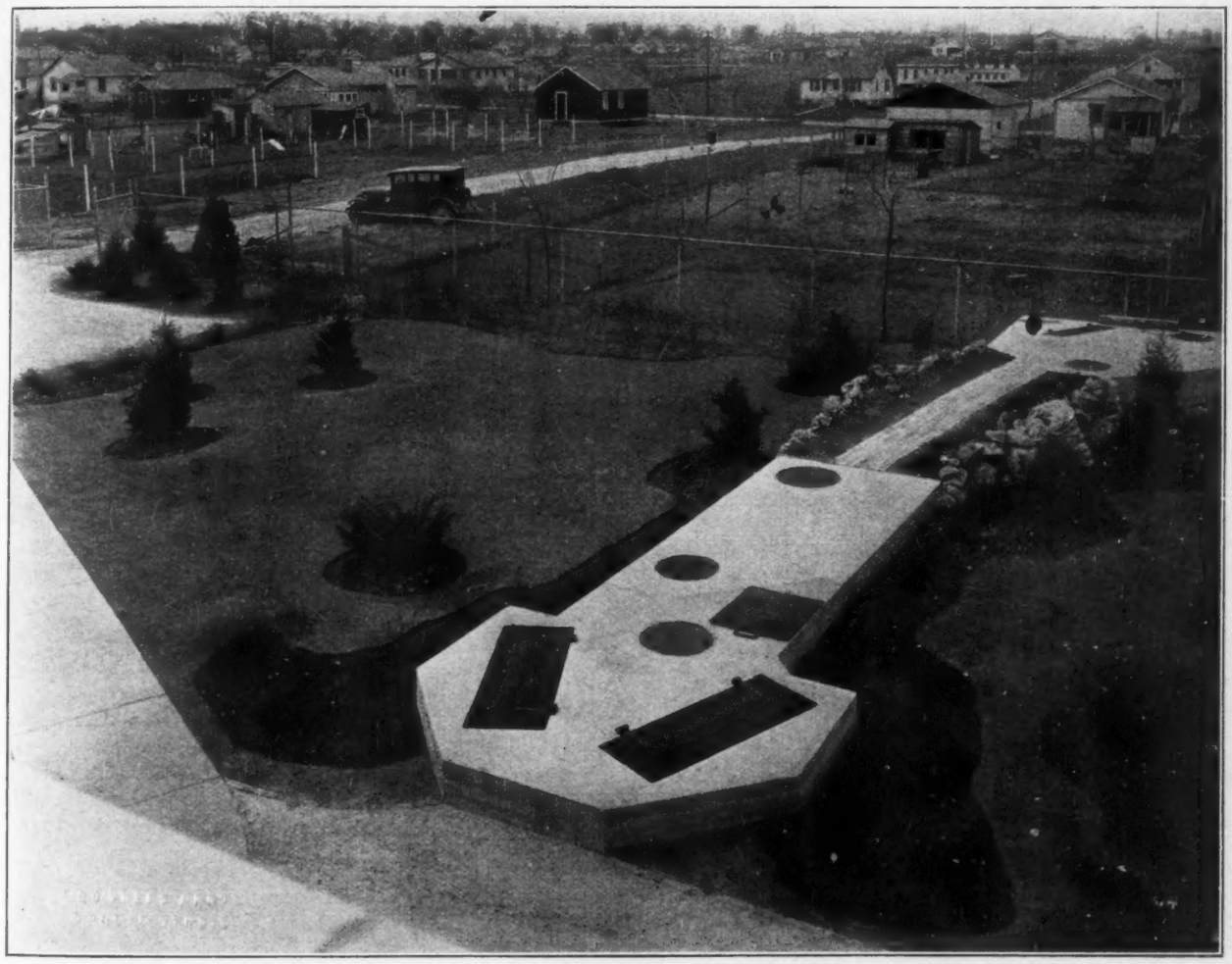
at the same time prevent odors that formerly escaped as the sewage was sprayed onto the filters. The remainder of the sewage, receiving only sedimentation, would be chlorinated to delay putrefaction with the consequent development of odors until the flow reached East Branch of DuPage River where additional dilution was available. This project was approved by the Illinois Department of Public Health and a permit was issued by the State Sanitary Water Board.

The sewage treatment works with the additions made according to plans prepared by McClenahan and Tholin are well described and illustrated in an article by A. L. Tholin in *Sewage Works Journal,* July, 1932, pp. 655-64.

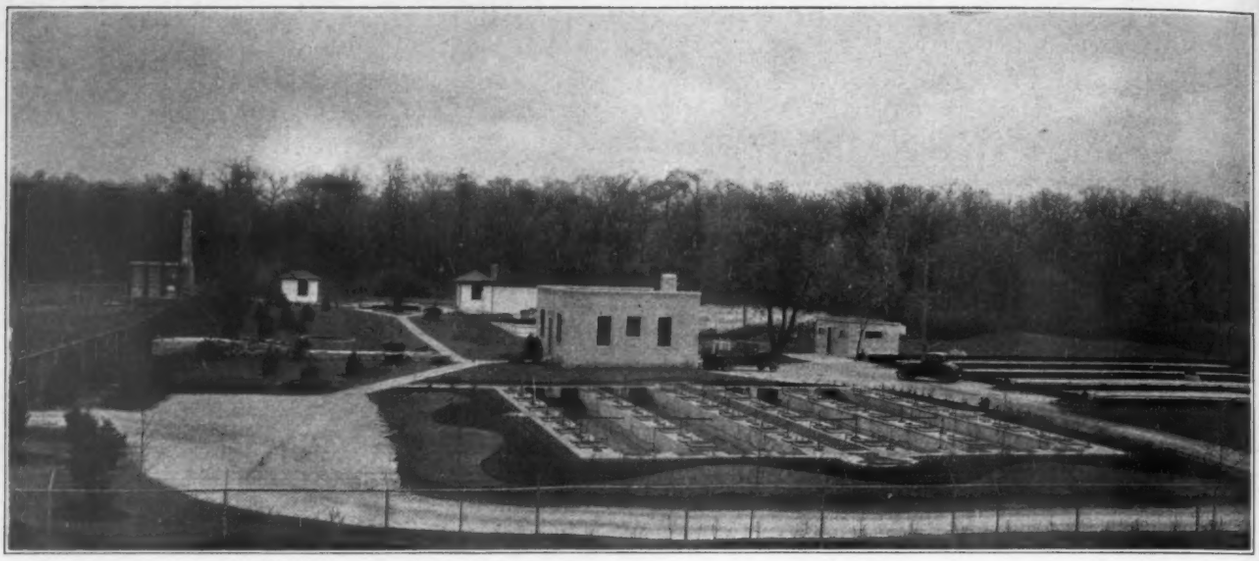
The original sewage treatment works, comprising an Imhoff tank, sprinkling filter and secondary settling tank, was considered satisfactory to serve 5,500 persons and was not altered except for the provision of gas collection equipment on the Imhoff tank. The new construction, designed to serve 18,000 persons, included Imhoff tanks, with provision for gas collection, sludge drying beds, a combination screenings incinerator and waste gas burner, and an administration building which houses the sludge pumps, gas boiler, chlorination equipment and laboratory.

The Downers Grove sewer system was built to serve as separate sanitary sewers. The flow to the sewage works is materially increased during and following rains because of excessive ground water infiltration and some illegal storm water connections. There are no industrial wastes.

Chlorine is applied by three Wallace and Tiernan vacuum type machines arranged so that chlorine solution may be delivered from any of the chlorinators to any of three points in the plant. The installation is unusual in that the chlorine scale platforms and most of the pip-



Downers Grove Sewage Works: Showing Residential Property Adjoining. This Picture Was Taken Shortly After the Additions Had Been Made to the Sewage Works and the Grounds Had Been Landscaped. The Landscaping and Beautification of the Sewage-Treatment Works Had a Psychological Effect Upon Nearby Property Owners Who Had Been Annoyed Previously by Odors from the Old Plant. The Splendid Appearance of the Sewage Works Site Has Since Stimulated Nearby Property Owners, Including Former Complainants to Improve Their Own Lawns and Yards.



Downers Grove Sewage Treatment Works. To the Left of the Site Are Residences Shown in Another Picture

ing are located in the chlorine storage room while the chlorinators with the scale beams are located on the opposite side of the storage room wall.

Last year the reduced income from taxes in the district made necessary very careful conservation of funds and chlorination was carried on only during the most critical months of March to October inclusive.

The sewage flowing to the old Imhoff tank was dosed with about 10 p.p.m. of chlorine at the screen chamber. The sewage flowing to the new Imhoff tanks was dosed with about 15 p.p.m. at the diversion manhole before sedimentation and about 9 p.p.m. at the new tank effluent manhole just before discharge to the creek. These dosages gave chlorine residual of 0.3 to 0.6 p.p.m. at the old Imhoff tank inlet, 0.06 to 0.4 p.p.m. at the new tank inlet, 0.01 to 0.2 p.p.m. at the old tank outlet weir and 0.2 to 0.7 p.p.m. at the new tank outlet to the creek.

From the standpoint of prevention of odors at the plant and vicinity the chlorination was very successful. No complaints have been received either by the state or by officials of the sanitary district since the new plant units were placed in service. One complainant, who lives near the plant and had submitted several petitions in protest against previous conditions, was interviewed recently and commented very favorably upon the improvement that has been made.

B. O. D. determinations of value have not been made but frequent dissolved oxygen determinations during chlorination demonstrated an appreciable improvement in the condition of St. Joseph Creek. About ¼ mile below the sewage treatment works St. Joseph Creek consistently showed a dissolved oxygen content of over 3.5 p.p.m. with an average chlorine residual of about 0.3 p.p.m. On two occasions when the well pump broke and caused a failure of chlorine solution water supply for short periods abrupt drops in the dissolved oxygen content of the stream were noted, once from 4.5 p.p.m. to 0 and on the other occasion from 5.6 p.p.m. to 0.7 p.p.m.

The stream banks and bottom were kept free of sewage fungus growths during chlorination but upon discontinuance of the use of chlorine in October the growths returned and became very profuse later in the winter.

During the entire season of 1932, chlorine was used for 204 days at a chlorine cost of $4.41 per million gallons of all sewage treated. Figures showing the division in chlorine cost between the old and new plants for the entire season could not be obtained but such separated cost figures are available for July to October, inclusive, during which period the total cost per million gallons averaged higher than the above stated cost for the entire season. From July to October, inclusive, an average dosage of 98 pounds per million gallons of chlorine was applied to the sewage passing through the old plant, at a chlorine cost of $5.92 per million gallons and 162 pounds of chlorine per million gallons was applied, costing $9.71 per million gallons, to the sewage passing through the new Imhoff tanks, of which 94 pounds per million gallons were applied to the raw sewage and 68 pounds per million gallons to the tank effluent.

The results obtained have shown the wisdom of the project of the Downers Grove Sanitary District Board and their engineers, McClenahan and Tholin, and have demonstrated the soundness of the decision of the state in the issuance of approval and a permit. We do not consider chlorination of sewage as a substitute for complete treatment, but doubtfully there are other places confronted with local conditions, such as prevailed at Downers Grove, where chlorination can be used temporarily or permanently to supplement partial treatment and thereby correct conditions causing complaints and economically solve sewage treatment problems.

The authors are indebted to A. F. Brevillier and A. L. Tholin, President and Engineer, respectively, of the Downers Grove Sanitary District for information and pictures included in this article.

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Water at 50 Ct. Per Barrel

The village of Hatch in Dona Ana County, New Mexico, whree it has been necessary to haul drinking water from a spring three miles away and sell it for 50 ct. a barrel, is assured of a new waterworks system as the result of the action of the Board of Dircetors of the Reconstruction Finance Corporation in approving the purchase of $16,500 of the town's revenue bonds at 6 per cent, payable semi-annually over a period of 20 years, subject to a test suit. The town will build a complete new waterworks system. The source of supply will be the Rio Grande River. Although drinking water is hauled from a spring, some of the residents of the town have private wells, but the water is said to be hard alkaline and unpalatable. It is estimated that the new waterworks system will reduce insurance rates 25 to 35 per cent.

B. E. Beavin, Annapolis, Md., Acting President and President-Elect of the Association.

MEETING OF MARYLAND-DELAWARE WATER AND SEWERAGE ASSOCIATION

A. W. Blohm, Baltimore, Md., and Edw. S. Hopkins, Baltimore, Md., Secretary and Treasurer, respectively.

THE Maryland-Delaware Water and Sewerage Association held its seventh annual conference in Baltimore, Md., on May 4th and 5th, at the Southern Hotel. In spite of conditions the largest number ever to attend a conference of this association were present, the registration being something more than 175.

President R. C. Beckett being unable to attend the conference the meetings were presided over by B. E. Beavin, Vice President—later elected President.

The address of welcome was made by Bernard L. Crozier, Chief Engineer of the City of Baltimore, Md., who paid high tribute to the 11 Chiefs of Bureaus in the City's Department of Works. Mr. Crozier outlined the more important recent developments in water, sewerage and sanitation in the city. Among these were the new Pretty Boy dam and the 13,000 feet of 84 inch concrete pipe line connecting the Montebello filters with the service reservoir. He referred to the program of improvements under way at the sewage treatment works to total $200,000 and the new $425,000 garbage incinerator recently completed and now in operation.

Mayor Howard Jackson of Baltimore was a guest at the annual dinner and made a brief address of welcome in which he featured the importance of the work being done by members of the Association.

Jordan Makes Dinner Address

Harry E. Jordan, Superintendent of Filtration of the Indianapolis Water Company, was the principal speaker at the dinner. His address which centered around the theme of "Devotion to Service" was inspiring. He urged the participation of water works personnel in community activities, believing from experience that this was an important factor in harmonious relationships between the Water Department and the community. He stressed the importance which should be placed on the appearance of water works plants, nothing being so fruitful in securing the respect and good will of the consumer as neatly kept works. In addition, the attitude of the employee toward his job and his superiors would likewise be materially affected by the appearance of the surroundings in which he worked. Discipline and cleanliness, he thought to be the chief items making toward satisfactory water works operation and satisfied operators. In commenting on quality of water, Mr. Jordan stressed the need for considering the quality of the product supplied the community as one would the quality in merchandising any other commodity. It was now requisite to produce water which was to be desirable in every respect—pleasing to the taste as well as in appearance: And that at any cost. With equipment, materials and processes now available to managers of water works the failure to do this was now no longer excusable.

At the business meeting the following officers were elected:

President—B. E. Beavin, Engineer, Annapolis Sewerage Commission, Annapolis, Md.

1st Vice President—C. J. Yauter, Supt. of Filtration, Washington, D. C.

2nd Vice President—L. D. Shank, City Manager, Dover, Del.

A. W. Blohm of the Maryland Dept. of Health was re-elected Secretary and

E. S. Hopkins was continued as Treasurer.

L. R. Voris of Hagerstown, Md., was elected to the Executive Committee.

The 1934 meeting will be held in Washington, D. C.

Technical Papers and Discussion

"Steam Control in Maryland," by F. H. DRYDEN, City Engineer of Salisbury, Md.

Mr. Dryden, who is a member of the Water Resources Committee of Maryland, reviewed the contents of the report made by that Committee to the Governor of Maryland. He said that the State had been delinquent in matters pertaining to the studies and control of its natural water resources and that the use of its ground waters and streams had gone too long uncontrolled. The report of the temporary committee had revealed conditions which led to the passage of a legislative act establishing a permanent Water Resources Commission composed of the Chief Engineer of the State Department of Health, the State Geologist and others. Study incident to the preparation of the report of the temporary committee had revealed much that could be accomplished by a Water Resources Commission, looking toward stream regulation as a major item of value to industry and municipalities and the equitable use of the State's waters by all.

Abel Wolman, who had served as Chairman of the temporary committee and now Chairman of the permanent Commission, recited the difficulties encountered in getting the bill through the legislature at this time when new Commissions of any sort were being frowned upon.

"Cast Iron Pipe and Fittings for Sewer House Connections" by H. R. DEVILBISS, Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

The author being unable to attend on account of an accident, his paper was read by N. L. Owings of the same organization. Mr. Devilbiss' paper recited the advantages accruing from the use of 12 to 18 foot lengths of class 50 (centrifugally made) 4 inch cast iron pipe in making house connections to sewers and the use of cast iron "cut-in" fittings for connecting to the sewer. The "cut-in" now used had been developed by R. B. Morse, Chief Engineer of the District and the author. The

practice of installing Y's for future house connections had been discontinued in favor of the "cut-in" connection, made when required, by cutting a hole in the sewer and inserting the "cut-in" fitting made tight with jute packing and cement mortar—the whole operation requiring but 30 minutes. The use of the light weight cast iron pipe was started in 1930 and in 1932, 60 per cent of all connections had been made with this pipe. Studies had been made of all available pipe and costs before selecting the centrifugal pipe and use of poured joints of a lead substitute. The average cost per installation in 1932 had been $42.14 as compared with $41.40 for 6 inch terra-cotta in 1927 and $43.33 in 1928. This, notwithstanding the fact that 6 inch terra-cotta cost 8.79 cents per foot

F. H. Dryden, City Engineer, Salisbury, Md.

M. J. Ruark, Engineer, Department of Works, Baltimore, Md.

as against 35 cents per foot for the cast iron pipe in 1932. The advantages from the use of cast iron pipe and poured joints of a lead substitute would be found in the greatly reduced number of joints, a tight line and one into which tree roots could not penetrate as they had other types of joints used previously. In three years not a cent had been spent on maintenance of the cast iron connections in service.

B. E. Beavin read a discussion prepared by Mr. Monroe, Chief Engineer of the Anne Arundel County Sanitary District which stated that cast iron pipe and "cut-in" fittings had also been used in the Arundel District. Roots had penetrated the best cement joints and asphalt was now being used on terra-cotta pipe. He thought that the first cost of terra-cotta pipe would prove cheaper but would prove more troublesome and costly to maintain because of root troubles and leakage.

M. J. Ruark, Engineer, Department of Public Works, Baltimore, Md., said that the 4 inch diameter pipe, if smooth, was preferable to 6 inch in which solids would accumulate more readily than in the smaller size. He had seen roots 100 to 150 feet long in sewers. He thought the idea of using a "cut-in" connection a very good one. He had known of cases where roots entered through joints made of asphalt but he thought the workmanship to be at fault.

R. B. Morse, Chief Engineer, Washington Suburban Sanitary District, in reply to a question, said that the chief advantage from the use of 16 to 18 foot pipe was the reduced number of joints and the doing away with "lips" on cement joints. Selection of cast iron pipe had been made only after care and study of 4 inch soil pipe and cast iron as against 6 inch terra-cotta.

(*Ed. Note*: Mr. Devilbiss' paper appeared in the May issue of Water Works and Sewerage.)

Profitable Utilities

"Public Utilities in Small Towns" by L. D. Shank, City Manager of Dover, Del.

Mr. Shank's paper called attention to the varied duties and vicissitudes of the manager of a small city, but his accomplishments proved what might be done to save money for the taxpayers if unhampered by political interference. Some of the things done by the author were cited to prove his point, among which, he enumerated the following. The three wells equipped with an obsolete type of air lift pumping equipment had been displaced by a 12 inch well equipped with a Cook strainer and a modern Byron-Jackson deep well centrifugal pump which delivered direct into the mains. The cost of pumping had been cut from $1,200 per month to $500 as a result. This, even in the face of increasing consumption from 450,000 to 750,000 G.P.D. The generating station had been enlarged from 400 to 2500 K.W. and at the same time reducing the cost of current from 7 cents to 8 mills per K.W. a profit in 1932 on electric current production of $87,000 had resulted. Furthermore, the water works profit had been increased to $12,000.

Mr. Shank stressed the advantages to be gained by a city through the employment of efficient engineers to advise the authorities. Privately owned companies did so and municipalities could follow the example with profit. Mr. Shank discussed the value of a fully metered system, advocated the installation of a gate valve at each fire hydrant and decried the practice of changing the type of hydrants predominating on a system.

W. M. Krumbine, Superintendent of Utilities, Easton, Md., complimented Mr. Shank and said that he could also relate what it meant to have the co-operation of city officials and citizens with the management of utilities. He advocated setting up of a uniform system of account keeping to aid cities in comparing costs of utilities operation. He said that the cost of pumping at Easton had been reduced 74 per cent as the result of increasing the size of important mains and the installation of an elevated tank to smooth out pumping operations.

Filter Washing and Filter Sand Discussed

"Filter Sand and Washing Experiences" by Carl J. Lauter, Chief Chemist, Filtration Plants, Washington, D. C.

The new filters at the Dalecarlia plant, equipped with the Armstrong type of slat underdrains over a false bottom, had given much trouble from hard spots and mud balls. A rate of wash of 18.5 inch rise per minute had proved to be inadequate. A 27.5 inch rise had helped some after cleaning the sand with a fire hose stream (¾ inch nozzle under 50 lbs. pressure) played with caution on the surface of the drained beds. After trying various schemes, including air and water jets the fire hose scheme had proven the most effective, care being taken not to hold the stream at one place too long at a time. By this procedure the sand bed was kept clean and even. Wash water consumption had been 2.5 per cent.

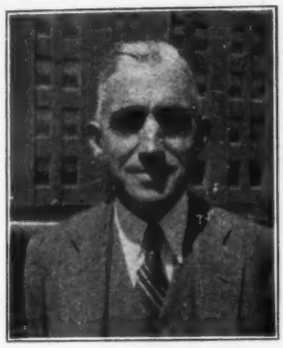
The specification for the new filters had stipulated sand of 0.45 m.m. effective size and an attempt had been made to secure it by filling with sand of 0.30 m.m. size and washing out the fines. With the underdrain system installed that had been impracticable. Experiments in filter washing had shown the most effective washing procedure for the Dalecarlia filters to consist of a triple boost, short period, water application i.e. water on, then off, then on, and finally off again. The scheme continued to look good after 5 months' use on selected filters and may preclude the necessity of changing the sand. The present aim was to procure 30 per cent sand bed expansion during washing.

J. W. Armstrong in discussion, presented some of the

most recently procured results from seven cities co-operating in sand and filter washing studies. Mr. Armstrong suggested that the expression in terms of inches rise of sand-bed surface was more readily understood than the expression in terms of per cent expansion. He said that the recent studies had revealed that surprising results could be secured by use of coarse sand and that 0.6 to 0.8 m.m. sand was giving excellent results in well operated plants, and furthermore, beds of larger size sand were more easily kept clean than could be the smaller. For instance, when considering efficiency of wash in terms of dirt removed from the sand during a 3 minute wash, the 0.32 m.m. sand was only 32 per cent effectively washed, whereas the 0.6 to 0.8 m.m. sand had been 60 to 80 per cent effectively washed.

J. V. CANNON, Chemist in Charge of Filtration, Hagerstown, Md., reported that the Hagerstown filters filled with a good grade of sea sand with effective size 0.45 m.m. and uniformity coefficient of 1.6, were in first class condition after five years of service and using the recently frowned on wash rise of but 24 inches per minute. The sand bed was 30 inches deep on 18 inches of graded gravel. Laterals were on 8 inch centers with drilled orifices pointing down. The good condition of the filters had been maintained without any especial effort other than a yearly caustic soda treatment of the top 2 inches of sand.

In reply to a question, Mr. Armstrong advocated prechlorination of raw or applied water to keep down slime accumulation on the sand grains and thereby maintain a cleaner washing bed.



Harry H. Hall, Assistant Chief Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

H. L. Maier, Chief Engineer, Street and Sewer Department, Wilmington, Del.

"Cellar and Open Area Connections to Sanitary Sewers" by ELWOOD JOHNSON, Engineer of Maintenance, Division of Sewers, Washington, D. C.

Mr. Johnson said that cellar drains into sanitary sewers were not permissible in Washington. Formal permits were granted for connection of as much as 20 square feet of open area to sanitary sewers but that a 30 day notice would terminate the permit if abused. Experience had shown the need of close inspection, because cases on record had revealed that at times 42 per cent of the sewage flow had been traced to illegal connections with open areas.

HARRY H. HALL, Assistant Chief Engineer, Washington Suburban Sanitary District, Hyattsville, Md., said that illegal connections of cellars and open areas was a widespread problem. Gorging of sewers and cellar flooding resulted. The question was, what to do about it? The Washington Suburban Sanitary District allowed connections from dry cellars and not more than 20 feet of open area but enforcement of the regulation was difficult to say the least. He felt it to be an important topic for consideration in the future.

M. J. RUARK, former Sewerage Engineer, Baltimore, Md., said that Baltimore ordinances prohibiting connections of cellars or open areas to the sanitary sewers had been rigidly enforced but it was his opinion that connection of cellars should be permitted and sewers designed for it. The use of ejector type cellar drainers require 10 gallons of water under pressure to remove 1 gallon of cellar water and, he thought, should not be tolerated by owner or municipality.

"The New Baltimore Garbage Incinerator" by O. H. SCHROEDL, Engineer in Charge, The Foreman Company, Baltimore, Md.

Mr. Schroedl's firm has the 5 year contract to operate the new incinerator at Baltimore and to collect rubbish. The garbage is collected and delivered by the city. The new plant equipped with Pittsburgh-Des Moines incinerator units has a capacity of 600 tons of garbage and rubbish, mixed in ratio of 65 per cent garbage to 35 per cent rubbish. The plant was built in the remarkably short period of 5 months at a cost of $425,000 which was paid for by the operating company and the plant automatically goes to the city after the 5 year period of contract. Only general specifications were drawn by the city—the successful bidder being permitted to supply his own plans and specifications, provided 3 such plants had been in successful operation previously.

Mr. Schroedl said that no odors resulted from the operations so long as a temperature of 1250° F. or better was maintained in the fire box. The average of 1450° F. was not difficult to maintain with less than 35 per cent rubbish fed with the garbage, the mixture being burned at the rate of 70 lbs. per hour for each square foot of grate area.

The Foreman Co. works under three separate contracts at the following prices per ton:

Collecting rubbish	$4.10
Incineration of rubbish	0.80
Incineration of garbage delivered by city trucks	1.85*

*Includes the cost and amortization of the plant over a 10 year period.

It is estimated that the city will save $324,000 per year when comparing present costs with cost of garbage and rubbish disposal during previous years.

The plant was inspected by members following the meeting.

H. L. MAIER, Chief Engineer, Street and Sewer Department, Wilmington, Del., gave the Association the benefit of Wilmington's experiences in garbage and rubbish incineration. In 1932 the cost of collection and handling of wrapped garbage had been $3.07 per ton and adding incineration cost of 80 cents per ton, gave a total of $3.87 per ton including the cost of 180 lbs. of coal burned per ton of garbage incinerated. The 1933 cost would be even lower viz. $3.48 per ton.

"The New Sewage Treatment Works of Wilmington"—by H. L. MAIER, Chief Engineer, Street and Sewer Department, Wilmington, Del.

Mr. Maier described the new sewage treatment plant serving a small section of Wilmington, Del., and presented some operating observations. The plant, which cost $225,000, makes use of rotary type sprinkling filters and separate sludge digestion (2 cubic feet per capita). Mr. Maier was high in his praise of the two circular filters with rotating distributors which operate on a head of but nine inches. The sludge digesters are equipped for heating and have floating covers. The two clarifiers are equipped with Link Belt sludge scrapers and P. F. T. Marlow sludge pumps. The filters are 75 feet in diameter and 5.5 feet deep, operating on the 18 inch

Miss Gipe, of the Maryland State Department of Health, who understands the "lingo" which she has taken down in shorthand for all seven of the annual meetings.

A. T. Feeney, Engineer, Water Department, Wilmington, Delaware.

maximum available head. The plant is now treating but 34,000 gallons per day and operating data presented is therefore not indicative of the ultimate performance of the plant.

"Forestation for Watershed Protection"—by F. W. BESLEY, State Forester, Baltimore, Md.

Mr. Besley recited the history of silting up of reservoirs due to denuded water shed areas. In one actual case in Maryland the reservoir at Illchester had been filled up in 10 years. Forests on water sheds would reduce soil evaporation by 24 per cent and he added that it was well established that evaporation from free water surface was 2.5 times greater on the outside of forests. Baltimore had planted 1 million evergreens on 700 acres of water shed and the York (Pa.) Water Company had put out 680,000 evergreen trees on 700 acres. The New Haven Water Company had had a forest under management for 20 years or longer and revenue from sale of the timber and fire wood covers costs of maintenance. Trees planted along the edge of reservoirs added beauty as well as being useful. Bank erosion could best be stopped by laying green willow logs which root and sprout. Scotch pine for the poorest and dryest lands, white pine for intermediate areas and spruce for reservoir margins were the most satisfactory trees. Native black locust could be planted in gullies and harvested for valuable fence posts. For close cover in 5 years (tree tops touching) plantings are made on 6 foot squares and in furrows following the contour of the land.

Mr. Besley illustrated his talk with lantern slides showing the methods of stopping soil erosion, cleaning reservoirs by hydraulic methods and other operations.

C. J. BRUCE, Superintendent, Evitt's Creek Water Company, Cumberland, Md., said that the Evitt's Creek reservoir, in a densely forested area, had but 2 inches of silt deposit after 17 years of service. He outlined their program of planting on water shed areas which in 1933 called for 15,000 trees. Red pine and Norway spruce had been selected from past experience. White pine was used for ornamental purposes. They had their best results from planting seedlings into a wedge shaped hole made by sticking a spade in the ground and working it backward and forward.

A. J. FEENEY, Engineer, Water Department, Wilmington, Del., said that they had started planting a number of white pines.

L. H. ENSLOW, called attention to the forestation work done at several places wherein the labor was performed by men paid out of unemployment relief funds and cost the Water Department nothing. He also pointed out the profit which could be made by growing and harvesting Christmas trees on water shed areas. Planting nut bearing trees had been tried but without success but the Christmas tree projects had better chances of proving self supporting.

"Automatic Pumping Stations on the Baltimore Water Supply System"—by LEON SMALL, Engineer of Water, Baltimore, Md.

Mr. Small described the functioning of automatic outlying booster pumping stations at Catonsville, Pikesville and Towson, Md. By ingenuous devices installed by the General Electric Company and a telephone located in the station it was unnecessary to have a man visit the stations more frequently than once weekly, to switch over the pumps and change the Venturi charts. A general inspection of the station is made once monthly.

Each station equipped is capable of reporting by code over an ordinary telephone circuit the exact status of operating conditions at the station. Two elements are required. The first is a rotating switch wired to various parts of the equipment, i. e. motors, pumps and pressure gauges. The other opens the telephone at the station and starts the reporting system in operation—thereafter closing the 'phone when the code message has been repeated twice. To learn the status of the station it is only necessary to go to the nearest 'phone and call the number in the customary manner. The 'phone operator plugs in and the connection starts the two elements to function. The code comes over the wire revealing which pump is operating, the pressure on the main, the depth of water in the reservoir and signs off O. K. unless something is wrong. If that be the condition, it indicates whether the trouble is within the station or on the outside. The foreman making the check up will immediately know the approximate cause of the trouble and be prepared to correct it before visiting the station.

Mr. Small with the use of a telephone and loud speaker impressively demonstrated the system by calling the station from the platform and getting reports which were clearly audible to the audience. Then by pre arrangement, having a man to alter conditions at the station, followed another call whereupon a new report came through by code indicating the new condition.

Upon question it was revealed that the equipment cost but $550.00 per station which was well worth the price. During and following electrical storms, when a report from the station could be had at the foreman's bedside any hour of the night or as frequently as desired, the system was worth about any price in his opinion.

"Sewage Treatment in Germany," was the subject of a talk made by S. L. DORSEY, Engineer of the Veteran's Administration, Washington, D. C.

Mr. Dorsey ran several reels of motion pictures, picturing sewage treatment as practiced in Germany, many of which he had taken on a recent visit.

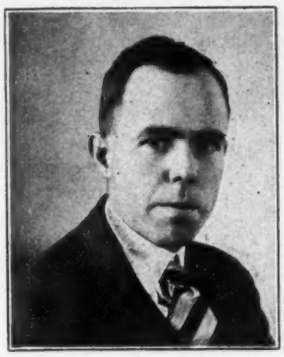
Carl Heckmer, Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

Stanton L. Dorsey, Sanitary Engineer, U. S. Veterans Bureau, Washington, D. C.

A STUDY OF FERRIC CHLORIDE TREATMENT OF SEWAGE AT GRAND RAPIDS, MICH.

By E. F. ELDRIDGE[1] and N. G. DAMOOSE[2]

FERRIC chloride came into prominence in sewage treatment a few years ago in the reconditioning of sludge prior to drying on vacuum filters. For this purpose it has proven to be superior to alum and other coagulants and is in general use at a number of treatment plants most of which are of the activated sludge type.



E. F. Eldridge

Some attempts have recently been made to introduce the use of ferric chloride in water filtration as a coagulant. Advantages are claimed for this chemical over alum which is in general use. Improved manufacturing methods have made possible a reduction in the cost which makes its use more attractive in this field than in the past.

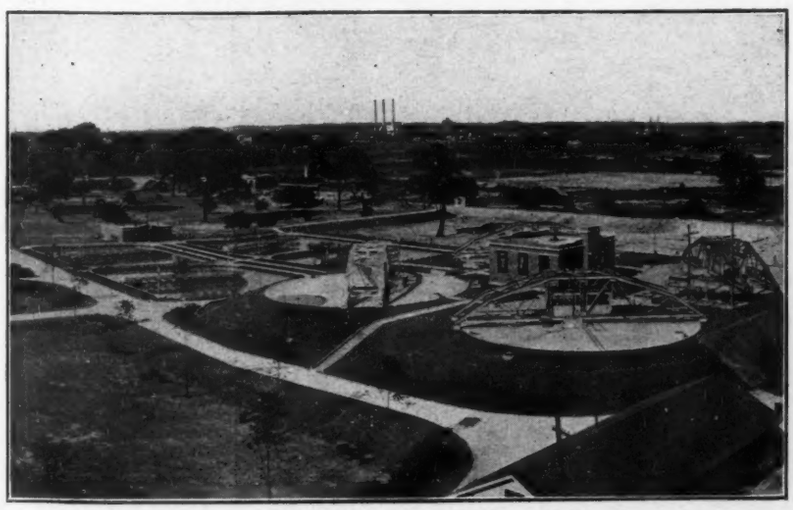
Rudolfs, Setter and Baumgartner[3, 4] in 1929 suggested the addition of small quantities of ferric chloride to raw sewage prior to settling. This application was not an attempt at chemical precipitation, but was an endeavor to coagulate or "floc out" an additional quantity of the finely divided solids. Their investigations showed that the settling of solids was much more rapid in the treated sewage and that a considerable increase in removal was obtained with settling periods below 30 minutes and with doses of ferric chloride of from 2 to 15 p.p.m. Results from application of the treatment to plant scale conditions indicated, however, that the advantage in suspended solids removal was largely lost with longer detention periods.

[1]Research Assistant, Engineering Experiment Station, Michigan State College, East Lansing, Mich.

[2]Chemist and Assistant Engineer, Sewage Treatment Works, Grand Rapids Mich.

[3]Wm. Rudolfs, Proc. N. J. Sewage Works Assn. (1929).

[4]Wm. Rudolfs, L. R. Setter, and Wm. Baumgartner, Sewage Works Journal, Vol. 1, p. 398 (1929).



Sewage Treatment Works of Grand Rapids, Mich.

The Situation at Grand Rapids

Many municipal sewage treatment plants are in a situation similar to that at Grand Rapids where the oxygen conditions in the receiving stream are such at certain periods of the year that an additional removal of solids and oxygen demanding materials is necessary as a safety measure. The cost of providing secondary treatment for this short period annually does not seem warranted. Some method of treatment which will have a low initial cost and which can be applied seasonally as required is desirable. An additional removal of 20 to 25 per cent of the suspended solids and B.O.D. at such periods would often be all that is necessary to maintain satisfactory conditions in the stream.

Ferric chloride treatment to increase solids removal was thought to be one of the possible methods which might fulfill this requirement. The studies reported herein were undertaken in order to determine the efficiency of the ferric-chloride process under plant conditions and also to obtain some cost data which might be compared with other types of treatment.

Experimental Work

The settling tanks at the sewage treatment plant at Grand Rapids consist of four 70-foot square Door tanks arranged in pairs. Each pair is connected to an air agitated inlet conduit about 150 feet long, six feet wide, and five feet deep. The incoming sewage is divided in a control chamber, one half going to each pair of tanks. From the conduits the sewage passes over movable weirs into the settling tanks. These tanks have a capacity detention period for normal flow of about one and one half to two hours.

One pair of tanks, designated as No. 1 and No. 3, were selected for the studies. No. 3 tank was to be treated and No. 1 untreated. Since there was no assurance that each tank received its full quota of the sewage, it was necessary to build a weir in the outlet conduit of No. 3 to measure the flow through that tank. Hourly readings were taken of the gage showing the head over the weir and the flow was calculated.

The equipment for applying the ferric chloride consisted of a storage barrel with a syphon connection to a dosing box. Since metal parts will deteriorate when in contact with the ferric chloride solution, the dosing box was made of a crock sink in which a constant level was maintained by means of a glass float and wood shut off on the syphon.

Almost all of the sewage received at the treatment plant is pumped and the variations in flow occur in steps as the different pumps come into operation. By regulating the pumping it was possible to maintain the flow at three different stages of comparatively constant volume. Three feed syphons were calibrated to deliver the desired volume of ferric chloride solution for these three stages of flow.

Four composite samples were taken, one

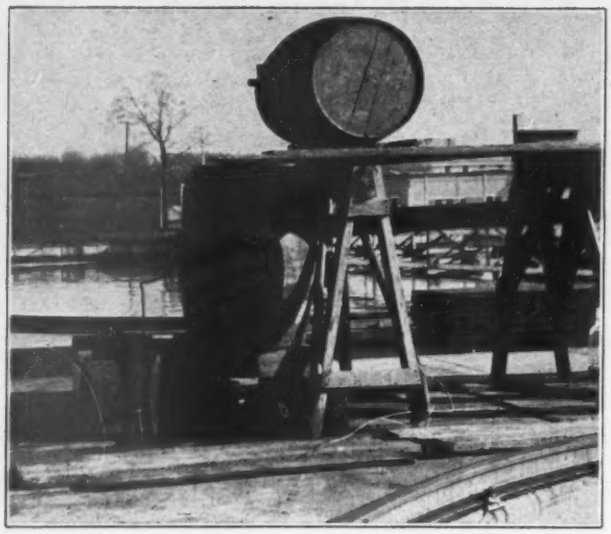


Fig. 1—Experimental Ferric Chloride Treatment, Grand Rapids, Mich., Showing Supply Barrel, Storage Barrel and Dosing Box.

from the influent and one from the effluent of each of the tanks. These composites were made up of hourly samples taken according to flow. Considerable care was taken in the collection of these samples in order that they would be truly representative of the sewage or as nearly so as possible. Each hourly sample was made up by taking equal portions of the influent or effluent at ten points along the inlet or outlet conduits. These ten portions were poured together, mixed and a measured sample taken.

Analyses were made of each of the composites for suspended solids, 5-day B.O.D., and chlorine demand. The suspended solids determinations were made on 200 c.c. portions poured through three weighted Gooch crucibles. Each determination was checked. During the last three days of the studies the hourly samples as well as the composites were examined for total count of bacteria and B. Coli index. These examinations were made at the Grand Rapids laboratory of the Michigan Department of Health.

Four different doses of ferric chloride (3, 5, 7, and 10 p.p.m.) were applied each over a period of several days. The sludge from primary clarifier No. 3 (the treated sewage) was all pumped to one of the four digesters. The sludge from both No. 1 and No. 3 was measured and samples taken for analysis. The samples were made up by compositing portions of the sludge taken at ten minute intervals during the pumping operation.

The results showing the effect of the various applications of ferric chloride on the removal of suspended solids, B.O.D., and chlorine demand are given in Table I. The results were rather erratic as would be expected when working under practical conditions where the sewage is quite variable. In all cases, except with the 3 p.p.m. dose, a greater efficiency in suspended solids removal was obtained through the clarifier handling the treated sewage. The column headed "Per cent increase" was prepared by assuming that the normal efficiency of the plant was represented by the per cent removal of tank No. 1. Dividing the percentage increase in No. 3 by the per cent removal of No. 1 gave the increased efficiency.

Solids Removal.—Representative sampling of influents which contain comparatively large particles of suspended solids is very difficult. It is the opinion of the authors that it can be safely assumed that the sewage entering these two tanks is practically the same in spite of the fact that the analysis of the influents showed some variation. Representative sampling of the effluents, on the other hand, is not as difficult since the solids are quite finely divided and the sewage has become more equalized by being held in the tanks. Efficiency studies of these two tanks made prior to these experiments showed that the two effluents were about the same in suspendid solids content and that the two gave about the same efficiency of removal. The averages of 11 tests made during August and September of 1932 showed the following suspended solids results:

Tank 1. Influent 125 p.p.m., effluent 63.5 p.p.m., per cent removal 49.1.

(*Continued on Page 209*)

Fig. 2—Experimental Ferric Chloride Treatment, Grand Rapids, Mich., Showing Supply Barrels to Be Rolled Into Position for Use.

Looking back at a few A. W. W. A. Convention *Groups of Yester-Year*

At Minneapolis, Minn.—August, 1894
Pres. Jas. P. Donahue, Davenport, Iowa

Courtesy, Ross Valve Manufacturing Co., Troy, N. Y.

Courtesy, W. F. End, Ross Valve Co., Troy, N. Y.

Does anyone recognize young Burt Hodgman in his first long pants, on the seat behind the driver? We bet he is wearing "gallouses" also i. e. suspenders of 1902.

At Chicago—June, 1902

Pres. Wm. R. Hill, New York City

A party on a "rubber-neck wagon" of that day.

At Chicago—June, 1902
Pres. Wm. R. Hill, New York City

Courtesy, W. F. End, Ross Valve Co., Troy, N. Y.

Courtesy, J. B. Ford, Ford Meter Box Co., Wabash, Ind., and Victor Arnold, Phoenix Meter Co., N. Y.

At Detroit, Mich.—June, 1903

Pres. C. H. Campbell, Charlotte, N. C.

Courtesy, Guy C. Northrop, Hydraulic Development Co., New York City

At Louisville, Ky.—June, 1912

Pres. Alexander Milne, St. Catharines, Ont.

Pres. C. H. Campbell, Charlotte, N. C.

Courtesy, Ross Valve Manufacturing Co., Troy, N. Y.

At Boston Mass.—June, 1906
Pres. Benjamin C. Atkins, St. Louis, Mo.

Courtesy, Victor Arnold, Phoenix Meter Corp.

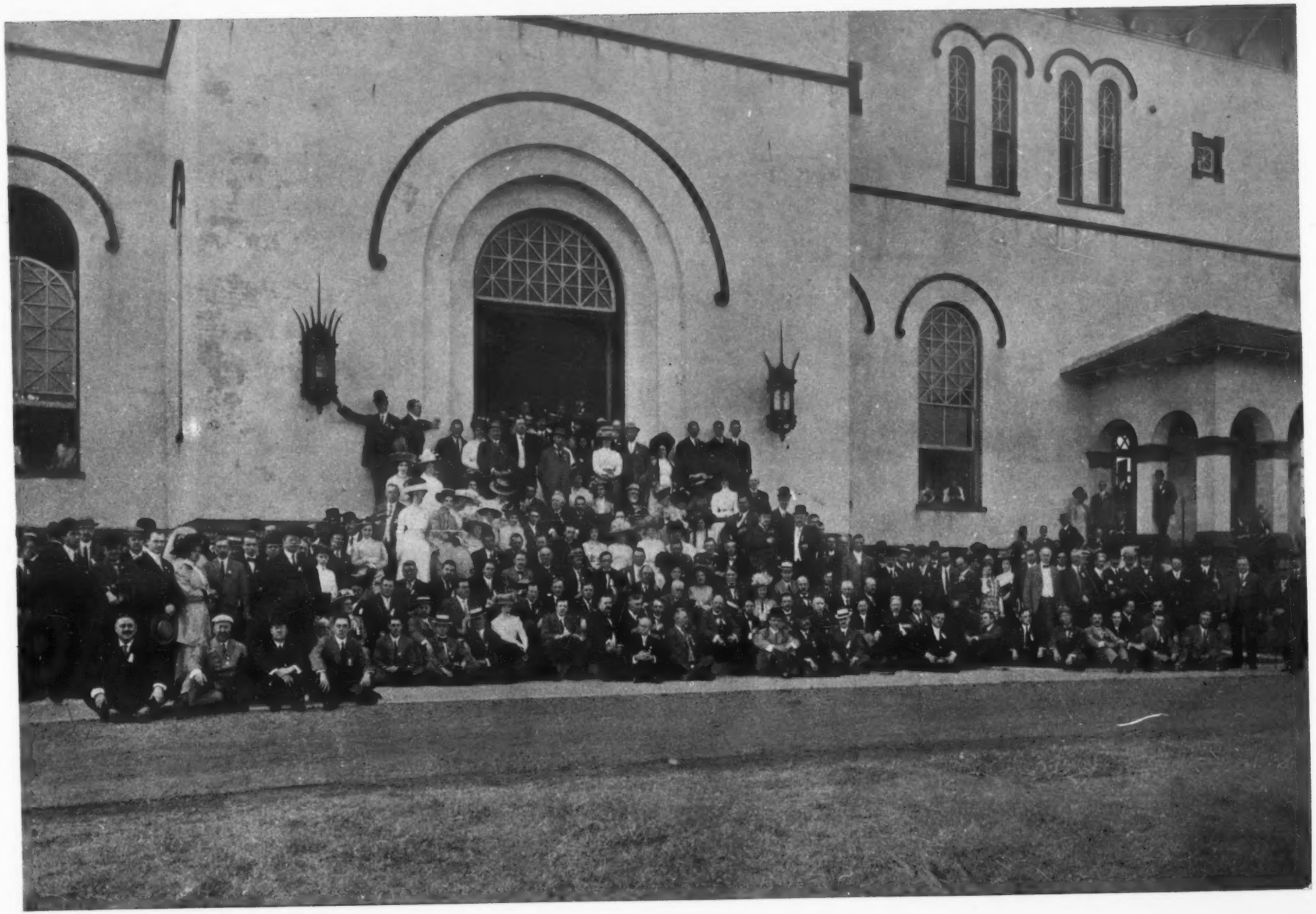
At the Country Club, Richmond, Va.—May, 1917
Pres. Leonard Metcalf, Boston, Mass.

Courtesy, J. B. Ford, Ford Meter Box Co., Wabash, Ind., and Buffalo Meter Co. Buffalo. N. Y.

At Mount Vernon, Va.,
Washington Convention—May, 1908
Pres. George H. Felix, Reading, Pa.

Courtesy, Mrs. J. M. Diven, Troy, N. Y.

At Milwaukee, Wis.—June, 1909
Pres. D. W. French, Weehawken, N. J



Courtesy, Guy C. Northrop, Hydraulic Development Co., New York City

At New Orleans, La.—1910
Pres. Dr. Wm. P. Mason, Troy, N. Y.

Pres. Dr. Wm. P. Mason, LL.D.

TABLE I—FERRIC CHLORIDE TREATMENT

Sewage Data

(Tank 1 untreated; Tank 3 treated)

Date	Dose $FeCl_3$ p.p.m.	Flow Treated m.g.	Suspended Solids: Tank No. 1 Inf. p.p.m.	Tank No. 1 Eff. p.p.m.	Tank No. 1 % Red	Tank No. 3 Inf. p.p.m.	Tank No. 3 Eff. p.p.m.	Tank No. 3 % Red	Tank No. 3 % Increase	Biochemical Oxygen Demand: Tank No. 1 Inf. p.p.m.	Tank No. 1 Eff. p.p.m.	Tank No. 1 % Red	Tank No. 3 Inf. p.p.m.	Tank No. 3 Eff. p.p.m.	Tank No. 3 % Red	Tank No. 3 % Increase	Chlorine Demand: Tank 1 Eff.	Tank 3 Eff.	Tank 3 % Red
Jan. 18	3	6.1	114	72	37.0	109	86	22.0	....	145	87	39.0	128	90	30.0	....	....	....	....
Jan. 19	5	6.3	116	67	42.8	103	56	45.5	6.3	118	77	34.8	105	75	28.5	....	....	....	....
Jan. 20	5	6.0	159	84	47.2	163	64	60.7	28.6	136	86	36.8	130	80	38.5	4.7	13.7	13.7	no
Jan. 21	7	6.3	92	65	29.2	100	55	44.5	34.0	90	58	36.2	98	45	53.8	48.7	11.3	11.3	no
Jan. 22	7	6.3	243	135	44.7	252	101	59.8	33.8	90	53	41.6	82	32	60.8	45.6	12.5	10.0	20.0
Jan. 23	7	6.3	95	54	43.9	110	48	56.2	28.0	160	100	37.7	104	90	35.7	....	6.3	5.0	20.0
Jan. 24	10	6.4	85	66	22.5	98	50	49.0	118.0	115	115	No	130	108	17.0	+	....	....	....
Jan. 25	10	6.2	130	63	51.7	137	56	58.7	13.6	110	85	22.7	145	98	32.4	42.7	26.3	24.0	9.0
Jan. 26	10	6.0	400	128	68.5	372	82	77.3	14.5	230	130	43.5	170	65	61.8	42.2	13.8	8.8	36.5
Jan. 27	10	12.6	387	137	64.8	357	105	70.5	8.8	140	130	7.2	130	115	11.5	60.0	8.8	7.5	14.5
Jan. 28	10	12.0	75	46	39.6	90	51	43.6	10.4	...	...	....	...	...	....	....	6.0	4.8	20.0
Average	7	p.p.m.	145	85	40.5	154	76	49.4	22.0	113	70	38.1	95	56	41.1	8.0	10.0	8.8	13.8
Average	10	p.p.m.	215	88	59.0	211	69	67.4	14.2	149	115	22.8	144	96	33.3	46.0	13.7	11.3	17.5
Average, total			172	83	51.4	172	68	66.2	28.8	135	92	31.9	122	80	34.4	8.1	12.3	10.6	13.8

TABLE II—RAW SLUDGE DATA

(Tank 1 untreated; Tank 3 treated)

Date	$FeCl_3$ dose p.p.m.	Tank No. 1 Volume gallons	Tank No. 1 % solids	Tank No. 1 Total lbs. solids	Tank No. 3 Volume gallons	Tank No. 3 % solids	Tank No. 3 Total lbs. solids	Pounds solids 3 over 1	Pounds Fe_2O_3 added	Pound net increase	% increase solids removed	Tank 3 gas cu. ft.	Total plant gas cu. ft.
Jan. 20....	5	17,000	7.40	10,420	18,500	7.80	11,970	1,550	125	1,425	13.7	60,000	179,506
Jan. 21....	7	13,500	4.40	4,830	13,900	4.90	5,640	810	183	627	13.0	61,900	204,206
Jan. 22....	7	10,000	3.90	3,235	10,500	4.90	4,270	1,035	183	852	26.3	51,600	174,200
Jan. 23....	7	9,000	1.70	1,268	10,000	2.80	2,320	1,052	183	869	68.5	38,900	124,800
Jan. 24....	10	11,200	1.83	1,700	12,000	2.49	2,480	780	266	514	30.2	35,700	115,000
Jan. 25....	10	9,300	1.52	1,170	10,000	2.68	2,220	1,050	258	792	67.6	30,300	87,300
Jan. 26....	10	17,500	6.40	9,337	20,300	6.40	10,831	1,494	249	1,245	13.3	35,100	87,900
Jan. 27....	10	16,000	5.90	7,870	20,000	5.40	9,004	1,134	212	922	11.7	56,600	181,200
Totals.....				39,930			48,735	8,805	1,658	7,147	17.8	320,100	1,154,000

Tank 3. Influent 125.5 p.p.m., effluent 66.0 p.p.m., per cent removal 47.4.

Assuming the influents to be the same, the results shown on Table I are indicative of the effect of the ferric chloride. It will be noted that the higher the suspended solids, the greater the difference in removal. The sewage was comparatively weak during a part of these studies, which may account for the small differences at these times.

B.O.D. Reductions.—The B.O.D. reductions followed much the same course as the suspended solids except that on one day (Jan. 25) the situation was reversed. This situation cannot be accounted for unless we take into account the erratic nature of B.O.D. results in general. The results, however, showed that the tendency was toward a greater removal of B.O.D. in the treated tank.

The same was true with chlorine demand as was found with oxygen demand. Except for the period when only a small application of the chemical was made, the chlorine demand of the effluent from No. 3 was always lower than that from No. 1.

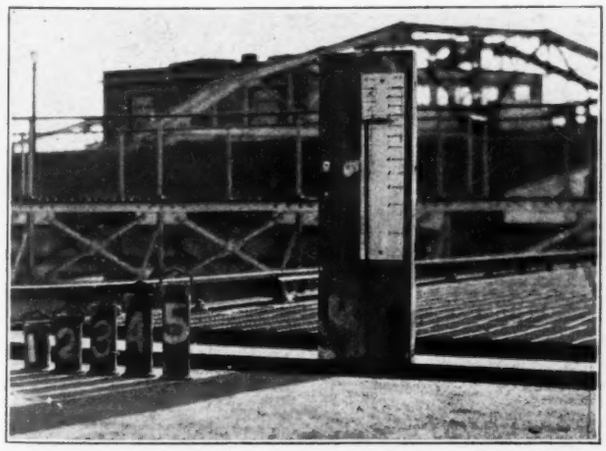


Fig. 3—Experimental Ferric Chloride Treatment, Grand Rapids, Mich., Gage in Outlet Conduit, Sampling Cans.

Reduction of Bacteria.—No difference in the bacteriological nature of the treated and untreated effluents was expected. The results of these tests were so erratic that no conclusions could be drawn and for that reason the data will not be shown here.

There was some difference in the results obtained from the 5, 7 and 10 p.p.m. doses. That is, the greater the dose, the greater the removal of suspended solids and oxygen demanding materials. Because of the large quantity of chemical required for doses higher than 10 p.p.m., it was decided that the higher doses should be tried out in a plant treating a smaller volume of sewage. The results of this subsequent investigation will be reported later.

Sludge Production.—Perhaps the best indication of the increase in solids removed is shown by a study of the sludge data (Table II). In all cases a greater volume of sludge was removed from the treated tank and in all but two cases, the sludge was higher in solids. After subtracting the weight of the anhydrous ferric oxide which was assumed to all be present in the dried sludge, the net increase in dry solids from tank No. 3 was 7,147 pounds. This was the total over an eight days' period and was 17.8 per cent greater than that removed by tank No. 1.

Effect on Gas Production.—The gas produced during this period was greater from Digester No. 3 receiving the treated sludge than from any of the other three digesters. Digester No. 3 gave a total of 320,100 cubic feet of gas during the eight day period while the average for the other three was 278,000 cubic feet. This was an increase of 42,000 cubic feet. Calculated on the basis of cubic feet per pound of dry solids, the treated sludge gave 6.57 cubic feet and the untreated 6.46 cubic feet. This indicates that the increase in gas production was probably due to the larger quantity of solids digested and not to any effect of the ferric chloride on the digestion.

Discussion

The results of these studies were not as conclusive as had been hoped. At no time was there a visual clarification of the effluent from the treated tank. However, the authors are satisfied that due to the extreme care taken in the collection and analysis of the samples, the results are representative of the actual conditions and that the increased removals indicated can be expected with ferric chloride treatment. Whether or not the increase in solids removed would justify the cost is largely dependent upon local conditions where the treatment is to be applied.

Because of the low solids content of the Grand Rapids sewage during most of the time when these studies were being made, the results obtained here might not be indicative of what might be possible with a stronger sewage. That greater removals could be expected under the latter condition is indicated by the results obtained on the days when the solids content were highest.

During the course of these studies no attempt was made to change existing conditions in the treatment plant. The object of the studies was to determine the feasibility of adding ferric chloride to sewage during short periods of the year in the existing settling tanks. For this reason, although the ferric chloride and sewage were well mixed in the air agitated conduits, the time it was held in these conduits was not sufficient to affect flocculation. This flocculation would of necessity take place in the comparatively quiet sewage in the settling tank and would not be equivalent to that obtained in coagulation basins or in "flocculators." The results of these studies, therefore, may be only representative of the minimum effects, since good flocculation is essential to this type of settling. This is a point which will require further study under more controllable conditions than existed at the Grand Rapids plant.

Plants contemplating ferric chloride treatment must procure a convenient set up for handling the chemical. Because of its corrosive action, concrete or metal tanks or equipment cannot be used. Rubber lined tanks and piping, hard rubber pumps, and rubber hose connections are best for this purpose. These are not expensive and with the proper equipment the handling of the chemical will not be difficult.

Conclusions

1. The application of ferric chloride to Grand Rapids sewage in amounts up to 10 parts per million ($FeCl_3$) showed an increase in the removal of suspended solids and a reduction in the B.O.D. and chlorine demand.

2. This effect was more pronounced with sewage of a high solids content than with a low content.

3. The percentage increase in suspended solids removal and reduction in B.O.D. varied over a wide range.

4. During the eight days of ferric chloride treatment the increase in dry solids removed as sludge was 17.8 per cent.

5. Gas production was not affected by the presence of the iron salt in the quantities added, viz.: 5 to 10 parts per million.

6. The use of ferric chloride during short periods of the year might be justified if the conditions in the stream approach the critical stage. The beneficial effect of small dosages as indicated by these studies was not as pronounced as was hoped for at the start.

Acknowledgments

The authors wish to acknowledge: the co-operation of the Dow Chemical Company of Midland, Mich., in furnishing the ferric chloride for this study; the interest and assistance of Mr. James Rumsey, Superintendent of Sewage Treatment Works, Grand Rapids, whose efforts made this study possible; and the assistance of Mr. T. H. Powers of the Michigan Stream Control Commission for the collection of the samples for bacteriological analysis.

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$80,000,000 Illinois State Public Works Jobs Recommended

Thirty projects to cost approximately $80,000,000 have been recommended by the governor of Illinois committee on unemployment.

Thirty-two of the construction projects would be in downstate counties to cost $5,457,050, and eight in Cook County would cost $74,582,850. The approved projects are to be recommended to the federal administrator of public works under the public works-industrial control bill.

The bill authorizes the president to make grants of federal funds to states, municipalities and other public agencies for construction, repair and improvement of public works.

The Cook County projects listed follow:

Sanitary District (sewage disposal)	$36,450,000
Cook County Nurses' home	2,000,000
Forest preserves improvements	1,500,000
South Park (outer drive bridge approach, breakwater and other improvements)	7,182,850
Lincoln Park (outer drive bridge)	2,000,000
City filtration plant (South Side)	22,000,000
Illinois waterway terminal	200,000
Ashland Avenue bridge and approaches over north branch of Chicago River	3,250,000

The downstate projects follow:

Apple River—water works	$ 35,000
Beardstown—water works	42,050
Bloomington—water works	175,000
Bushnell—water works	5,000
Canton—water works	40,000
Centralia—water works and relief sewer	234,000
Charleston—water works	87,000
Duquoin—sewage treatment plant	202,000
East Peoria—sewerage	250,000
Effingham—sewerage	35,000
Fairbury—water works	30,000
Forrest—water works	25,000
Joliet—water works	1,250,000
Joliet—sewerage	1,300,000
Joliet—Brandon road hydroelectric plant	1,300,000
La Salle	1,300,000
La Salle—water works	196,000
Morris—water works	75,000
Nokomis—water works	30,000
Paris—water works	40,000
Salem—sewage treatment plant	40,000
Taylorville—water works	30,000

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Dabney H. Maury

Col. Dabney H. Maury, a well known consulting engineer, died May 11 at his home at Chevy Chase, Md.

He was born in Vicksburg, Miss., March 9, 1863, and was graduated in 1882 from the Virginia Military Institute and then went to Stevens Institute of Technology, where he was granted the degree M. E. in 1884. For the next nine years he was engaged as engineer on various railroad building projects in Texas, mining engineering in the Republic of Colombia and some traveling in Europe and the United States. In March, 1893, he was made engineer and superintendent of the Peoria Water Co. at Peoria, Ill., which position he held until July, 1912, when he established his practice as a consulting engineer. During his practice he was consulted or retained by more than 250 cities in the United States and Canada. In January, 1924, he formed a partnership under the name of Maury and Gordon with F. G. Gordon which continued to April, 1927, when he retired and moved to Chevy Chase, Maryland, a suburb of Washington, D. C.

PROBLEMS INVOLVED IN PROVIDING SAFE AND ADEQUATE WATER SUPPLIES FOR OIL REFINERY USES

By SHEPPARD T. POWELL

Consulting Chemical Engineer, Baltimore, Md.

Sheppard T. Powell

THE refining of petroleum products requires large quantities of water and the provision for an adequate supply and effective purification is of vital importance to the successful operation of such industries. Present day refinery practice is demanding greater attention to water problems than was formerly considered necessary. There are a variety of water requirements in the processing of oils, which are of greater or lesser importance depending upon the specified products manufactured. In general, the important uses of water may be grouped under the following general classification:

1. Cooling water for condenser and similar uses.
2. Boiler feed water.
3. Fire protection.
4. Sanitary purposes, i. e. drinking water, preparation of food in commissaries, toilet facilities, etcetera.
5. General utilitarian uses.

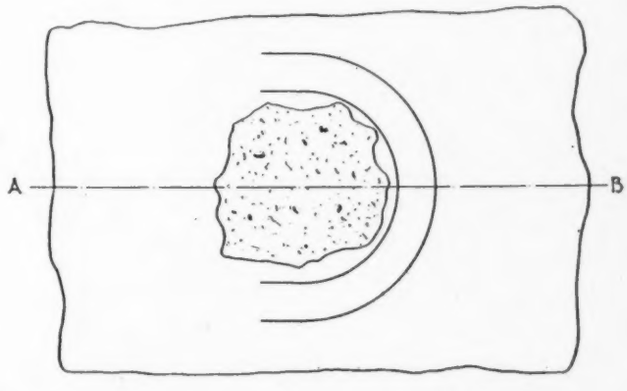
This classification is purely arbitrary but covers, in general, the major uses of water without indicating their order of importance. It is doubtful if the preferential water requirement in such an industry can be so allocated since these various uses are so correlated, one to the other, that inadequate provision for any specific requirement must affect adversely, to a greater or lesser degree, overall refinery efficiency.

The desired qualification of a water supply for general refinery use, is an ample volume of cold water containing only a limited amount of suspended matter and relatively non-corrosive. Although these specifications are not particularly severe, it is seldom possible to secure such a supply, from a single source. Surface and tidal waters may be secured which are relatively satisfactory in all respects, except as to temperature. Waters from deep wells, however, meet the requirements for temperature, but frequently are limited in volume and highly mineralized. Many well waters are extremely hard and may not be used for boiler feed purposes without treatment.

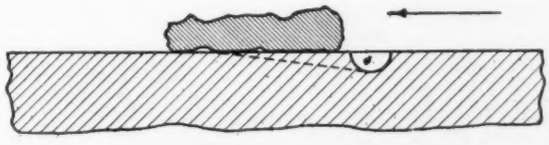
Many oil refineries are located on tidal waters which make necessary the use of salt or brackish water for condenser circulating water and well water or inland fresh surface water supplies for specific purposes requiring cold water or for boiler feed and other general refinery uses. If the major supply is from surface streams, particular attention should be given to salt water contamination of the surface water streams during drought and tidal conditions. Little consideration has been paid, in the past, to these conditions, but the recent drought has focused attention on the importance of such contamination. Many serious operating problems were experienced at refineries in Texas and on the Eastern seaboard during the 1931 and 1932 droughts and similar conditions may be repeated in subsequent dry years unless provision is made to cope with salt water.

Condenser Cooling Water and Corrosion

Corrosion of condenser tubes, on the water side, will vary with the character of the water used. Surface condenser tubes are generally manufactured from copper, brass or other alloys and are fairly resistant to fresh water corrosion, provided the supply is not seriously contaminated by sewage or industrial wastes. Salt and brackish water may be highly corrosive especially when contaminated by acid or other industrial by-products. Corrosion of condenser tubes results from the conversion of the tube metal into soluble metallic salts and leaching out of these products. The speed of this action is markedly influenced by low pH values of the water, oxygen, magnesium salts, iron, manganese and sulphur compounds. See Fig. 1. It has been demonstrated, also, that biological action resulting in the decomposition of organic matter may, under some conditions, accelerate corrosion of such metals. The correction of these prob-



Plan showing Semicircular Groove on the up-stream side of a Particle adhering to Tube Wall



Section Along A-B

Graphic illustration showing how Ferric Hydroxide or other material depositing on a Condenser Tube can result in Pitting

Fig. 1

lems is frequently a difficult matter and generalized recommendations are not possible since specific control procedure may only be indicated after a comprehensive study and allocation of all factors contributing to the losses encountered.

Boiler Feed Water

Satisfactory water for this service is the same as in any other industry, where large volumes of water are necessary for steam generation and where the percentage of condensed steam returned to the boiler is small. The type of water treatment best suited for proper conditioning of such supplies depends upon a number of factors, the most important of which are:

1. Type of boilers used.
2. Pressure, temperature and rating of the steam generating units.
3. Percentage of condensate returned to the boiler and the degree of contamination of such water.
4. Chemical composition of the raw water in respect to carbonate and non-carbonate hardness, chlorides, total suspended and soluble solids, sulphate dissolved gases and organic matter.
5. Space available for plant.
6. Intelligence and experience of operators in respect to industrial water purification problems.

In the past boilers were operated at relatively low pressures (under 200 pounds per square inch) and at low ratings. Within recent years there has been a marked trend towards higher pressures and temperatures and the rates of evaporation have been steadily increased. These conditions have required the use of much better feedwater than formerly was considered necessary.

An ideal feedwater is one which will cause neither priming nor foaming and will not result in scale formation or corrosion. The production of such water requires adequate processing since ideal supplies to fulfill these specifications are seldom obtained from natural sources. There are many types of water purification processes which may be employed to produce a satisfactory supply. The difficulties arising from inadequate industrial water treatment are due largely to improper choice of systems to meet the specific requirements or to lax operation after the water conditioning system has been installed.

In general, it is preferable to treat feedwater by external softening rather than chemical treatment within the boiler. There are cases, however, where internal treatment, if proper chemicals are used and if the treatment is intelligently controlled, will produce results equally as satisfactory as external treatment. The elimination of scale from boiler surfaces is not especially difficult with the exception of infrequent occurrences of certain silicate deposits. The completeness of the inhibition of scale depends upon the choice of treating systems installed to adequately soften the supply under the specific conditions and the intelligence of operation. Many factors influence the preference for a specific process and the choice of the plant installed should be made only after all operating conditions are oriented and evaluated.

The essential controlling factors influencing the type of any water treating system are, that, the finished product will have a minimum of dissolved and suspended solids and the cost of treatment will be commensurate with the benefits resulting therefrom. From the standpoint of minimum solids, the use of distilled water as obtained from evaporators is preferable to all other forms of treatment. Water so treated should contain less than eight parts per million and scale formation on tubes or drums of boilers will be negligible under ordinary conditions. The cost of feedwater purification by evaporation is fairly high and it is difficult to justify the use of such equipment if the percentage of "make-up water" exceeds 20 per cent of the gross amount of the total feedwater required. Since, in the majority of refineries, the amount of feedwater make-up exceeds this figure, feedwater treatment by evaporation is not generally practiced.

Softening feedwater by chemicals or by zeolites is now widely practiced at many refineries. Hot or cold lime-soda softeners, when the systems are properly designed and operated, will produce excellent results. In recent years phosphates, sodium aluminate or other coagulant have been employed in conjunction with chemical softening. By the use of phosphates and aluminate, it is possible to reduce the residual hardness in the treated water to a point lower than could be effected by the lime-soda treatment only. The primary value of these combination chemical treatments, in addition to producing a softer residual water, is for preventing the deposition of silicate scales. In many cases such treatment warrants the added cost necessitated by the use of these products.

The treatment of industrial water supplies by synthetic or natural zeolite has grown rapidly in recent years and many water treating systems of this type are now used for softening water supplies for boiler feed and general refinery uses. It is possible to produce a water having a somewhat lower residual hardness in the treated water than is possible by chemical treatment. Zeolite softening is not adaptable to the treatment of all waters. Waters containing high concentrations of sodium salts and high carbonate hardness may be treated somewhat more satisfactorily by chemical softening than by zeolites. Lime pretreatment followed by filtration and zeolite softening is practiced at some plants. The decision as to the choice of chemical treatment versus combined lime pretreatment, followed by a zeolite system must rest upon the cost of the systems and the difficulty involved in the operation under the specific conditions encountered.

Embrittlement of Boiler Steel

So much has been written in recent years concerning the embrittlement of boiler steel that there would seem to be little excuse for further discussion of this problem and its solution if it were not for the fact that such failures continue to occur. Three failures from this cause have occurred recently in plants having a staff of technically trained operators, and where the management had reason to believe that the feedwater conditioning was adequate.

There is still some controversy concerning the fundamental cause or causes responsible for this type of failure of boiler steel, which is commonly known as caustic embrittlement. Few, if any, of the research workers who have studied this problem in recent years have been convinced that all the factors involved in such failures have been determined. There is sufficient evidence, however, to clearly indicate that chemical action on boiler steel under certain conditions is a marked contributing cause for such action. Practical experience covering twenty or more years tends to confirm the findings of many of the research workers, that unbalanced water, namely, water high in sodium carbonate or bicarbonate and in the absence of appreciable amounts of sulphates can result, under some conditions, in cracking of boiler steel in a relatively short time.

When bicarbonates enter a boiler, they are usually decomposed by heat in a short time to give carbonates. These carbonates may be practically completely removed

from solution by any calcium or magnesium sulphate present, or in the absence of these metals they may remain in solution as sodium carbonate. If the feedwater is softened, calcium and magnesium will be largely removed, but the treated water will contain appreciable amounts of sodium salts. Sodium carbonate or hydroxide may also be introduced as such, directly into the feedwater, depending upon the type of treatment employed. Heat may further decompose sodium carbonate into sodium hydroxide under steaming conditions. The extent of the conversion of sodium carbonate into the hydroxide will depend upon the boiler operating pressure (temperature), the rating, and other operating conditions.

It is beileved by research workers that only the sodium hydroxide in a boiler saline is responsible for any embrittlement that occurs. Due to the difficulty in many cases of determining what part of the total alkalinity is due to sodium hydroxide, and what part is due to sodium carbonate, the total alkalinity, comprising both sodium carbonte and sodium hydroxide, is used in calculating the amount of sodium sulphate required for embrittlement prevention. This total alkalinity is determined, using methyl orange as the indicator, and the results calculated in terms of sodium carbonate. This is done in order that any error may be on the side of safety. Furthermore, laboratory investigation indicates that sodium carbonate may actually have the power of inhibiting embrittlement. Because of its progressive conversion, in the operating steam boiler, to the hydroxide, sodium carbonate must be regarded as at least to a large extent potentially hydroxide. Accordingly, notwithstanding that laboratory investigation has indicated that sodium carbonate may have properties of inhibiting embrittlement, it is the part of wisdom to base the measure of the inhibiting chemical requirements upon the total alkalinity.

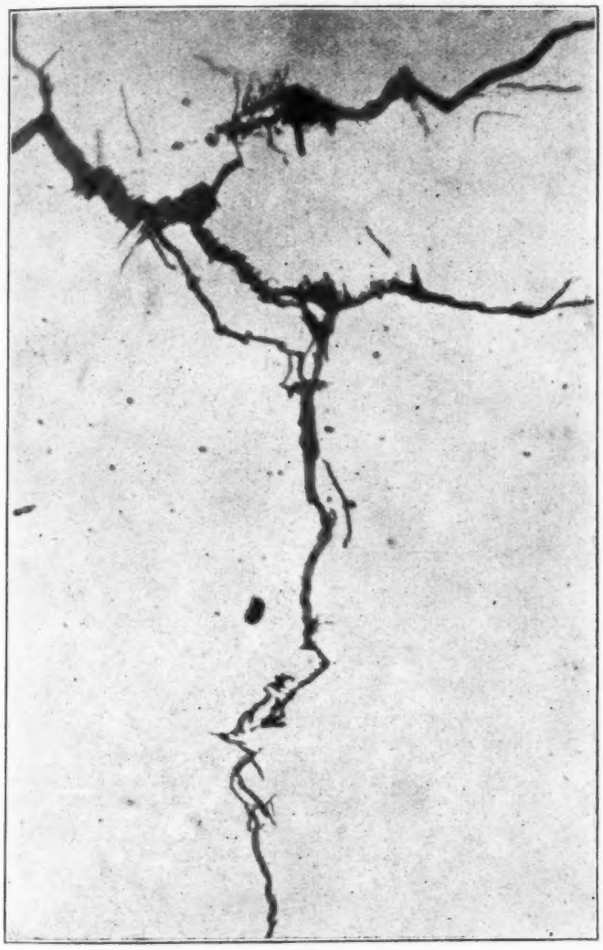


Fig. 2—Photomicrograph of an Unetched Sample of Embrittled Boiler Plate Showing Section of Crack. (Magnification 1000 Diameters).

Briefly, the conditions which result in embrittlement may be characterized as a combination of stress beyond the yield point and chemical attack of the metal. The chemical attack is favored by high concentrations of sodium hydroxide, and low concentrations of sodium sulphate in the boiler salines.

It is an established fact that the area of greatest stress in a fabricated boiler drum is in the riveted area, and it is in this area that the cracking of the boiler steel resulting from embrittlement occurs. See Fig. 2. The action is brought about by combination of chemical attack and stress. This form of chemical attack follows grain boundaries. When the chemical action starts it is restricted to the outer surfaces but as chemical action proceeds along the grain boundaries, stresses are concentrated at these points and as a result of the accelerated stresses the chemical attack penetrates into the metal and results ultimately in cracked metal.

The solution of the problem of embrittlement is so relatively simple that with our enlightened knowledge on the subject, there is now little excuse for the continuation of such failures. The maintenance of a given concentration of sulphates in the presence of sodium carbonate or caustic soda in the concentrated boiler salines is all that is required to eliminate the potential possibility of this form of failure. The amount of sulphates required to inhibit embrittlement of the steel depends on the pressure at which the boilers are operated. These ratios are as follows:

Working Pressure of Boilers pound gauge	Sodium Sulphate		Total Sodium Hydroxide and Carbonate Alkalinity calculated to equivalent sodium carbonate
0 to 150	1	to	1
150 to 250	2	to	1
250 and over	3	to	1

**For cases where this ratio should be higher see Bulletin No. 216 of the Engineering Experiment Station, University of Illinois entitled "Embrittlement in Boilers," 1930—pages 76-77-78.

The efficacy of this treatment has been clearly demonstrated by laboratory experiments and has been completely confirmed by actual operation in practice.

The material used for supplying the necessary sulphate radicle rests upon a number of conditions, and the choice of the treatment employed will depend on local conditions. Sodium sulphate is used more extensively than any other sulphate salt. Sulphuric acid and sodium bisulphate have been employed to some extent. The use of sulphuric acid for correcting ratios involves carefully designed and operated feeding appliances and should only be used where technical supervision is available. Sulphuric acid has a specific value for this service since on an equivalent basis it has a higher portion of sulphates than sodium salts.

Prevention of Corrosion in Boilers

Boiler water corrosion may be greatly inhibited by complete deaeration of the feedwater supply and the maintenance of the hydrogen ion concentration at 9.0 or higher. Where complete softening of the feedwater is effected the residual dissolved oxygen in the deaerated water should be maintained at less than 0.03 cc. per liter. In critical operation, even this small amount of dissolved oxygen may result in active corrosion and complete removal of the gas must be effected. See Fig. 3. To completely deaerate feedwater requires the use of a deaerating heater or well operated open heater and subsequent

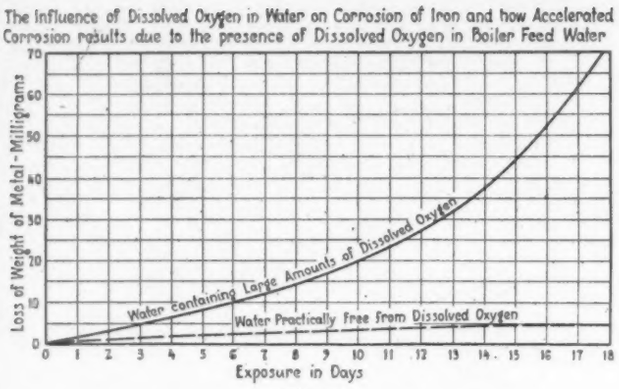

The Influence of Dissolved Oxygen in Water on Corrosion of Iron and how Accelerated Corrosion results due to the presence of Dissolved Oxygen in Boiler Feed Water
Loss of Weight of Metal - Milligrams
Exposure in Days
Water containing Large Amounts of Dissolved Oxygen
Water Practically Free from Dissolved Oxygen

Fig. 3

oxygen removal by de-oxygenating chemicals. Ferrous sulphite and ferrous hydroxide have been used for this purpose.

In some instances corrosion in boilers occurs beneath boiler scale. Such action is particularly insidious since accelerated corrosion may occur in a relatively short time and be unobserved. Operators should not assume that corrosion is absent when the tubes and drums are coated with scale. Such false confidence has resulted recently in two serious boiler failures.

Water Supplies For Fire Protection

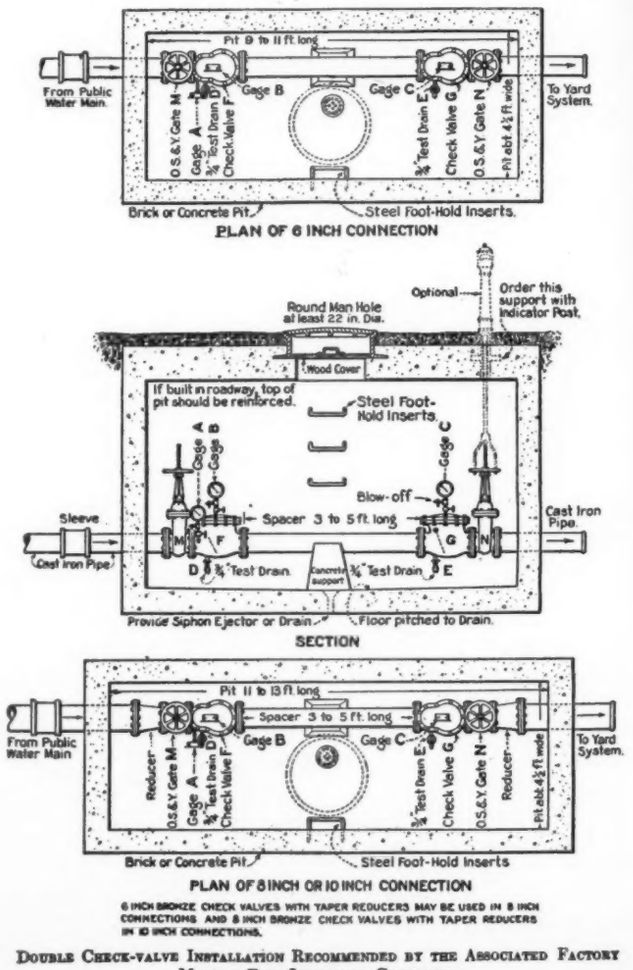
Possibly there is no industry where adequate fire protection is so necessary as that required for oil refineries. In addition to the use of fire foam and other protection measures, an abundant and adequate supply of water must be provided. Frequently, water for this service is from a contaminated supply and maintained as a separate distribution system. Such service is usually maintained under high pressure and careful attention is given to the distribution system and to the placing of fire plugs, sprinkling systems and other fire protection appliances. Unless extreme care is used in the operation of such systems, there is a potential danger of cross-connecting polluted and non-polluted supplies, either for expediency or through carelessness.

Some state health regulations prohibit any physical connection between contaminated and pure water supplies, while other states allow the connections of the two types of systems provided adequate construction precautions are taken to assure complete segregation of the two waters. The matter of adequate control in this respect is of the greatest importance, since numerous epidemics of typhoid fever and other intestinal diseases have occurred in recent years as a direct result of leaky valves installed on cross connection lines permitting direct contamination of the drinking water supply by polluted waters used for industrial purposes or for fire protection. Wolman and Gorman[1] in a comprehensive discussion of typhoid fever epidemics in the United States have made the following statement pertinent to the great potential danger of unprotected cross connections. This is given herewith verbatim:

"Although the greatest number of outbreaks in the United States was due to drinking water from shallow wells, unprotected cross connections and inadequate control over purification methods account for the largest numbers of cases of typhoid fever and dysentry, respectively. The public health importance of unprotected cross connections is further emphasized by the fact that this cause rated second in responsibility for total outbreaks and fourth for dysentry cases. From these figures the unprotected cross-connection may well be classed as the outstanding public health danger in water works operations."

Aside from the humanitarian aspect involved in the protection of workers in industries, the matter is of the greatest importance from the standpoint of sound business. Most employers or groups of employers responsible for the health of their workers cannot afford to ignore the necessity for cautionary measures which will completely eliminate the potential possibility of such calamities.

The majority of states in recent years have passed health regulations prohibiting the use of any cross-connections between non-potable and potable water supplies. At times there are certain contingencies which require connection between two supplies of this kind and most of the regulations and ordinances are so written as to permit such construction provided proper precautions are taken to safe-guard the public health. If conditions are such as to make absolutely necessary, the connection of contaminated and un-contaminated supplies during fires, some ordinances permit joining of the two systems by a direct pipe connection but require the removal of this connection as soon as the emergency ceases. Other regulations permit cross connections where two gate-valves with indicator posts and two check-valves of special design of the Factory Mutual Fire Insurance Company or equal are installed, and require further the installation and proper maintenance of emergency chlorinators for intensive sterilization of the water in the entire system. A double check valve installation is shown in Fig. 4.


Pit 9 to 11 ft. long
From Public Water Main
Gage B
Gage C
To Yard System
O.S.&Y. Gate M
Gage A
¾" Test Drain D
Check Valve F
¾" Test Drain E
Check Valve G
O.S.&Y. Gate N
Pit abt 4½ ft. wide
Brick or Concrete Pit
Steel Foot-Hold Inserts
PLAN OF 6 INCH CONNECTION
Optional
Order this support with Indicator Post.
Round Man Hole at least 22 in. Dia.
Wood Cover
If built in roadway, top of pit should be reinforced.
Steel Foot-Hold Inserts
Blow-off
Spacer 3 to 5 ft. long
Sleeve
Cast Iron Pipe
¾" Test Drain
Concrete support
Provide Siphon Ejector or Drain
Floor pitched to Drain
SECTION
Pit 11 to 13 ft. long
Spacer 3 to 5 ft. long
Reducer
Pit abt 4½ ft. wide
PLAN OF 8 INCH OR 10 INCH CONNECTION
6 INCH BRONZE CHECK VALVES WITH TAPER REDUCERS MAY BE USED IN 8 INCH CONNECTIONS AND 8 INCH BRONZE CHECK VALVES WITH TAPER REDUCERS IN 10 INCH CONNECTIONS.

DOUBLE CHECK-VALVE INSTALLATION RECOMMENDED BY THE ASSOCIATED FACTORY MUTUAL FIRE INSURANCE COMPANIES.

Fig. 4

[1] "The Significance of Waterborne Typhoid Fever Outbreaks," 1920-1930—by Abel Wolman and Arthur E. Gorman—Publishers, The Williams & Wilkins Company, Baltimore.

It is not only essential that the management of an industry supply safe water but that it shall be dispensed in a sanitary manner as well. It is customary to deliver water by means of drinking fountains established at various convenient stations throughout the works. Frequently, such appliances serve as focus of infection. A number of epidemics of septic sore throat, tonsilitis and other diseases have been traced directly to these so-called sanitary fountains.

In an investigation of drinking fountain facilities at the University of Minnesota some years ago, it was found, out of seventy seven so-called sanitary fountains there were fifteen different types, most of these permitting transmission of infection from the mouth of one person to another using the fountains. Laboratory investigations all demonstrated the inherent danger of the transmission of certain infectious diseases by vertical type bubbler fountains. Experiments at the University of Wisconsin, made about 15 years ago, showed that on one occasion forty-three out of seventy-seven fountains of this type were contaminated with streptococci and in a second investigation thirty-five out of fifty fountains were contaminated with this same disease producing organism. The primary reason for these studies was to determine the source of infection of an epidemic of tonsilitis which occurred at the University. Similar investigations at the University of Minnesota showed that out of seventy-seven drinking fountains examined, 80 per cent were infected with disease producing organisms.

Although there has been much agitation from time to time in respect to the potential danger of poorly designed drinking fountains and the transmission of disease, few industries have given any thought to the matter. An extensive survey of various industries in reference to these facilities was made by the Women's Bureau of the United States Department of Labor in 1930 and 1931. The summary of the findings issued by the bureau is enlightening and is given herewith as an indication of existing conditions in a large group of industries:

"Tests of the sanitation of drinking fountains show that all vertical jet fountains retain disease germs placed on them and that many angle jet ones can be contaminated by improper use. The American Public Health Association's standards for the design and construction of drinking fountains list the features which are essential for their sanitation. Most of the fountains in use at present do not meet these requirements. Moreover, the State laws and regulations on this matter do little more than prohibit the use of the common drinking cup. No State law requires that angle jet fountains be used. The Health Department of thirteen States and the Labor Department of four recommend the installation of angle jet fountains. Because of their importance to health, the Women's Bureau recommends that only the most sanitary drinking facilities be used and suggests that the standards of the American Public Health Association be required in the fountains installed in all places of employment."

The specifications referred to in the above report are as follows:

"STANDARD SPECIFICATIONS FOR SANITARY DRINKING FOUNTAINS"[2]

1. The fountain should be constructed of impervious material, such as vitreous china, porcelain, enameled cast iron, other metals, or stoneware.
2. The jet of the fountains should issue from a nozzle of nonoxidizing, impervious material set at an angle from the vertical, and at an elevation above the edge of the bowl, so that the end of the nozzle will not be flooded in case a drain from the bowl of the fountain becomes clogged.
3. The end of the nozzle should be protected by nonoxidizing guards to prevent the mouth or nose of persons using the fountain from coming into contact with the nozzle.

[2]American Public Health Journal and the Nation's Health. Vol. 29, No. 11, November, 1929, pp. 1224-25. Essential Features in the Design of Sanitary Drinking Fountains. Report of the Committee on Plumbing, American Public Health Association.

4. The inclined jet of water issuing from the nozzle should not touch the guard, thereby causing splattering.
5. The bowl of the fountain should be so designed and proportioned as to be free from corners which would be difficult to clean or which would collect dirt.
6. The bowl should be so proportioned as to prevent unnecessary splashing at a point where the jet falls into the bowl. Self-cleansing auto-splash rims are recommended.
7. The drain from the fountain should be connected to a separate waste pipe.
8. The water supply pipe should be provided with an adjustable valve fitted with a loose key or an automatic valve permitting the regulation of the rate of flow of water to the fountain so that the valve manipulated by the users of the fountain will merely turn the water on or off.
9. The control valve should be operated preferably by knee or foot action to avoid possible hand contamination.
10. The height of the fountain at the drinking level should be such as to be most convenient to persons utilizing the fountain. The provision of several step-like elevations to the floor at fountains will permit children of various ages utilizing the fountain. Elevations may be difficult to provide, however, at fountains recessed in walls.
11. The rate of flow and the pressure should be such that the water will not splash over the bowl. It should be at a rate of not less than one-half gallon per minute and at nozzle pressure not exceeding 5 pounds per square inch.
12. The waste opening and pipe should be of sufficient size to carry off the water promptly. The opening should be provided with a strainer.

Few manufacturers realize the potential hazard of infectious diseases which may occur at any time by failure to provide safe appliances.

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Typhoid Carriers

An interesting study of typhoid carriers in Lorain County, Ohio, was made recently by Dr. Henry R. O'Brien, Health Commissioner of the general health district. The notes following on this study are taken from the Ohio Health News of May 15:

Dr. O'Brien points out that prior to 1926 no record of a carrier was to be found in the county. That year's epidemic, in the village of Wellington, caused 154 cases through the use of raw milk and had its origin through a carrier of 20 years' standing. Six carriers, five women and one man, were found among the Wellington convalescents. Two of the women carried the organisms only about six months, and the man about two years. The other three women were positive at a recent date.

In 1930 a woman of 65 years was found to be a carrier. Her three-year-old grandson, ill with typhoid at the time, was the last of several members of the family who suffered with the disease since the grandmother had it in 1919.

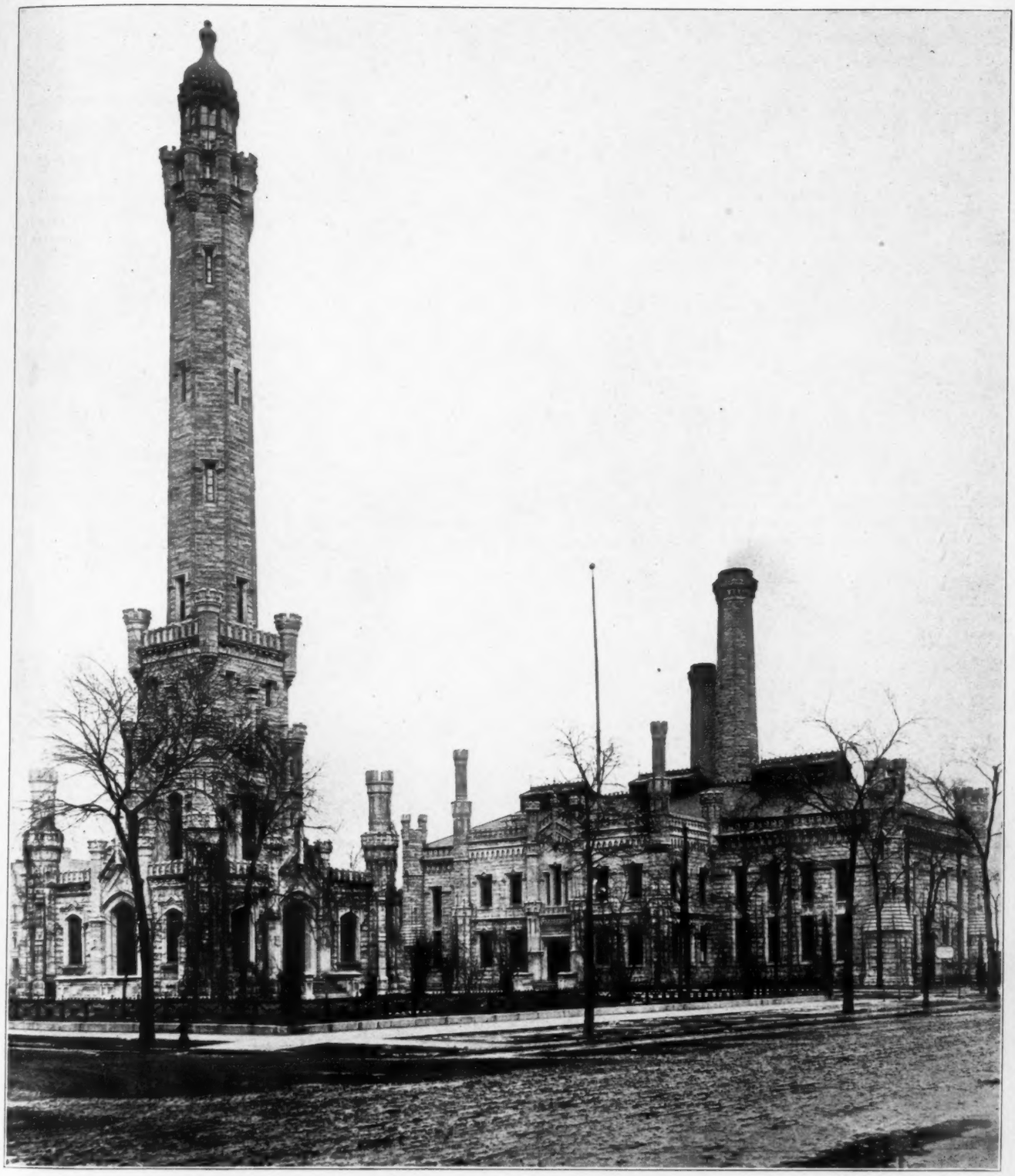
Although there was no record of a carrier in the county before 1926, other cases than the one just preceding have been traced to carriers antedating that year. In the spring of 1891 a boy of 10 or 11 years had typhoid fever, but so common was the disease in his home town (a lake port whose water supply was pumped directly from the lake) that the experience was regarded as nothing unusual. Forty years later—1931—when his daughter had typhoid fever, the doctor's inquiry developed the fact that the father had typhoid when a boy and a laboratory investigation demonstrated that he harbored germs of the disease. The menace of this specific carrier to the public is discernible in the fact that ever since boyhood he had been in the dairy business as producer, distributor or both.

In 1921 a colored man in the district had typhoid and, serving as carrier, transmitted it to his two-year-old daughter just 10 years later.

Today
(1933)

CHICAGO'S OLD WATER TOWER IN MODERN SETTING.
No Longer Used, But Preserved for Its Historic Interest and Beauty.

And Yesterday
(1869)



THE WATER TOWER AS IT WAS IN 1869.

The Pride of Chicago These 64 Years, But Referred to by the Poet, Oscar Wilde, When Lecturing in Chicago, as "That Castellated Monstrosity." Well, That Must Have Been the Day That John Bull and Chicago Severed Diplomatic Relations.

THE REGULATION OF CHLORINE APPLICATION IN SEWAGE ODOR CONTROL WORK

Methylene Blue Test Reveals Minimum Effective Dosage

By A. E. GRIFFIN
Research Laboratory,
Wallace & Tiernan Co., Inc.

CHLORINE is one of the most powerful and economical deodorizing agents known for sewage. Its value depends upon the fact that it does not mask the odors of hydrogen sulphide and other compounds but actually destroys them. In addition to this action the sulphide producing bacteria are also killed so that the production of odors is eliminated for some time subsequent to chlorination, depending upon the amount added and flow conditions through sewers or treatment works.

The problem in the control of sewage odors is not what to add but how much. Since the chlorine attacks first those oxidizable substances in solution, and thereafter the bacteria and organic matter in suspension, it follows that the sulphide in solution is among the first elements to be attacked. It also follows that the whole of the chlorine demand will not have to be satisfied because it is not necessary in this type of work to entirely sterilize the sewage. Likewise more chlorine should be added than necessary to barely neutralize the hydrogen sulphide because some of the reducing bacteria should be killed in order to prevent reformation of this odorous gas. Thus none of the ordinary chemical tests come very close to telling the amount of chlorine to be added. The sulphide measurement when applied alone usually leads to underdosing with attendant poor results and the chlorine demand test when used for control usually ends in overdosing with good results but consequent poor economy.

Methylene blue becomes decolorized in the presence of hydrogen sulphide and reducing bacteria. Thus so long as the blue color persists in a sample containing methylene blue no odor can exist and this test makes a very neat indicator of the presence of sulphides in sewage. Briefly, 0.5 cc. of a 0.10 per cent methylene blue solution is added to 250 cc. of sewage in a glass stoppered bottle, care being taken that no air is left between the liquid and stopper. The bottle is then stored in the dark at room temperature of about 20° C. The progress of the color discharge is noted at intervals. If the blue color holds for four hours no odors will appear within that period, provided the sewage passing through plant or sewer is not reseeded within that time with sulphate splitting organisms. Where there is a possibility of reseeding, as in a trunk sewer, chlorine should be added at the designated point until the methylene blue color holds for at least two hours at the point of discharge or at some critical point down sewer below the chlorine application.

The author of this article, confronted with the problem of controlling odors along a large and long trunk sewer, has developed a technic of chlorine control for odor elimination which has the appeal of being extremely practical.

There is no test more simple to perform than the well known methylene blue stability test. Sewage partially chlorinated to prevent odors, by destroying hydrogen sulphide and checking its reproduction, will not become odorous as long as the methylene blue added to it is not reduced—made colorless. Application of the test at critical points along the sewer has been demonstrated to be a practical control procedure productive of economy.

Practical Demonstrations

The writer found the chlorine demand of the joint meeting trunk sewer which runs through a residential portion of Elizabeth, N. J., to vary from 10 to 20 parts per million. Considerable sewage entered the trunk line between the point of chlorine application and the point of discharge. There seemed no way to gauge the chlorine dose other than by observation of hydrogen sulphide or odors and dependence on the absence of complaints, until the idea of chlorinating to the point where methylene blue color lasted at least two hours at the outfall was hit upon. When this method was put into practice the chlorine dose was reduced to 8 p.p.m. and resulted in complete absence of odors. The results are expressed graphically in Fig. 1.

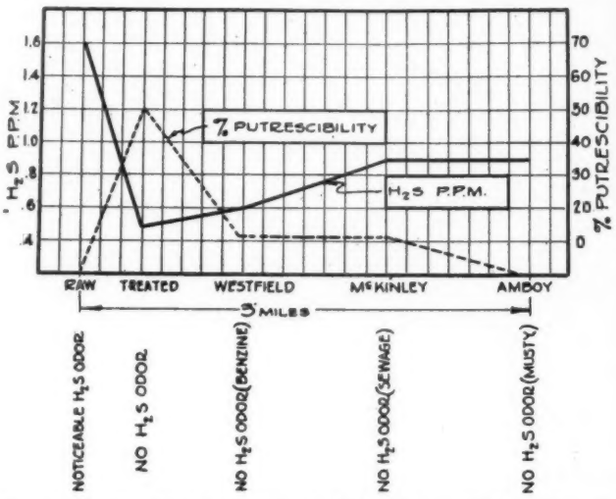


Fig. 1—Graph Showing Relationship Between Chlorination and Subsequent Changes in the Sewage

At Princeton, N. J., a new sewage plant consisting of settling basins, sprinkling filters and separate sludge digestion was placed in operation during the fall of 1932. Provisions were made for prechlorination for odor control. Up until the end of January, 1933, the dose of chlorine was regulated to satisfy the entire chlorine demand. This practice resulted in traces of chlorine almost continually in the effluent from the settling basins. At the writer's suggestion the chlorine was regulated during February by the methylene blue test. Chlorine was added in quantities sufficient to hold the color for eight to twelve hours in the

influent to the settling basins. This method of operation saved 50 per cent of the cost of the chlorine when compared with that used in the previous month, with the advantage that nitrification in the filter beds increased. The suspended solids in the filter effluent dropped and the turbidity was reduced from the maximum of 90 to 30. The following table gives the comparative data:

COMPARATIVE OPERATING DATA AT PRINCETON SEWAGE PLANT FOR JANUARY AND FEBRUARY, 1933

	January	February
Total flow	40,067,000	40,765,000
Pounds chlorine added (total)	1,736	833
Average dose of Cl (p.p.m.)	5.3	2.7
Av. residual Cl in effluent from settling tank....A. M.	.48	...
Av. residual Cl in effluent from settling tank ....P. M.	.0 to trace	...
Chlorine demand, raw....A. M.	2.5	4.7
Chlorine demand, raw....P. M.	7.5	10.5
Chlorine demand, filtered....A. M.	2.0	3.4
Chlorine demand, filtered....P. M.	3.0	5.0
Methylene blue decolorized (influent to tank after dechlorination) ....(Hours) A. M.	...	10
(Hours) P. M.	...	8
Turbidity of final effluent	47	26
Suspended solids in final effluent	16	9.6

Summary

1. Methylene blue is a satisfactory and practical indicator of the amount of chlorine to add to sewage for the control of odors.

2. The chlorine demand of sewage does not have to be satisfied in odor control work.

3. Constant over-chlorination will interfere with the proper functioning of trickling filters.

4. Over-chlorination of sewage applied to trickling filters may be prevented by control with methylene blue.

5. Odor control with chlorine is remarkably cheap when proper control is exercised.

Remarks

It must be admitted that this method is not absolutely accurate and that there can be many variations. It is, however, submitted in the belief that it is very useful and will greatly assist many operators in their odor control problems. Furthermore, when the test is used no attempt should be made to try to interpret it as a relative stability test. The persistance of the blue color is merely indicative that sufficient chlorine has been added to destroy sulphides present and check sulphide production for the period represented by the number of hours the blue color persists in the sample under observation. The test can be applied at any desired point down sewer, or through the treatment works, and the chlorine application regulated to insure the absence of substance reducing methylene blue at the point of sampling.

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NO FREE WATER AT MILWAUKEE.—The Water Department of Milwaukee, Wis., furnishes no free water to anyone. The rates, according to the 1932 report of the Common Council, are as follows:

Public fire hydrants, each, per year	$ 10.00
Public drinking troughs (large) each, per year	150.00
Public drinking troughs (small), each, per year	75.00
Public bubblers, each, per season (6 months)	50.00
Street sprinkling and flushing, per 1,000 gal.	.08
Public buildings, grounds and parks, per 1,000 gal.	.08

Weather Cycles

By HALBERT P. GILLETTE

SEVERAL thousand years ago the Egyptians built the "Nileometer," a well containing a gage on which the heights of the River Nile could be read. C. E. P. Brooks says that annual high and low water levels were probably recorded by them as far back as when the pyramids were being built. Those invaluable records have been lost, but starting 622 A. D. there is an unbroken record for 800 years, and a fragmentary record thereafter. The early parts of this record were kept by the Turks after their conquest of Egypt.

Since the ancient Egyptians had charted the constellations and had learned how to predict eclipses, it is certain that they recorded the annual levels of the Nile for the purpose of forecasting its runoff through the discovery of one or more rainfall cycles. Otherwise there was no object in building the "Nileometer." So the inference is plain that men have been trying for several thousand years to discover some mathematical order in Nature's control of weather, comparable to her order in the movements of the moon and the planets.

Joseph's interpretation of Pharaoh's dream perhaps indicates belief in a 14-year weather cycle. Curiously enough the next mention of a weather cycle, other than the annual cycle, is also one of 14 years. It was recently found that an associate of De Soto had recorded a great flood of the Mississippi River in March, 1543, and that the Indians had said that such floods occurred every 14 years.

The writer has found a 14-year cycle both in the annual ring thickness of the California sequoias and in the annual clay laminae, or varves, deposited in ancient glacial lakes. He has found that this 14-year cycle inverts its phase every 210 years. There is a 210-year rainfall cycle, and near its peaks the 14-year cycle attains its greatest amplitude, whereas it fades into insignificance near the times when phase inversion occurs. A peak of the 210-year cycle was due in 1543, or at the time of the great Mississippi flood witnessed by De Soto. The next peak of the 210-year cycle is due in 1963. Hence a peak of the 14-year rain cycle is due in 1935. However, there are a score or more of important rain cycles, and their combined effects often displace the peak of an expected cycle by a year or so. Based on certain rainfall records, a 14-year peak may occur in 1934.

The third earliest mention of a long weather cycle is that made by Sir Francis Bacon, who speaks of evidence of a 35-year cycle. A cycle of about that length is said to have been long known in the Island of Ceylon. By aid of the sequoia rings and the clay varves, the writer has found the mean length of this cycle to be exactly 36 years. Its last peak was due in 1916. This cycle is the phase inversion period of the 2-year cycle. For 18 years before and after 1916, the odd years have tended to be the wet years; but starting in 1934 the even years will tend to be the wetter years in California and in those regions that have the same phase as that of California. Many regions have exactly opposite phases; and in all regions having rainfall throughout the year, the winter phase is opposite to the summer phase of each cycle, both as to temperature and rainfall.

Regional oppositions of phase and periodic inversions of phase have been the greatest stumbling blocks in the search for weather cycles. Not until after four years of almost continuous investigation did the writer find periodic phase inversions of rainfall cycles, and only within the last few weeks did he find opposition of phase between winter and summer, also between spring and fall, as to each rainfall cycle.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor

Physical Chemist, Bureau of Engineering, Chicago, Ill.

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THE EVALUATION OF ACTIVATED CARBON

A SERIOUS problem confronting water purification chemists at the present time is developing suitable tests for activated carbon. It is not often that a material becomes almost indispensable in water treatment in so short a time as has been the case for activated carbon. The use of powdered activated carbon in public water supplies was started in 1930, and the number of water works now using carbon is quite large. It has become a suitable treatment for practically all kinds of objectionable tastes and odors, and this should insure much more extensive use of the material in the future.

Another reason for the popularity of carbon in addition to its effectiveness is that the water treatment operators know there is some amount of the material which will remove the taste or odor and that there is no danger of applying an overdose. With other treatments there is no such assurance. It is not until after these other treatments have been tried on the water for the particular taste or odor that we can be assured of the results. Not only this, but the tastes and odors change so often and vary so widely that with the use of treatment other than carbon the operator is constantly in fear that satisfactory results will not be produced. Being the only known substance which will remove certain tastes and odors, and being a substance which will remove practically all types of tastes and odors, carbon becomes almost an essential in water treatment.

New Carbon Manufacturing Companies Have Been Organized.—It is natural to expect that considerable use of carbon in the water works field would inspire companies to be organized for the production of this material, and this is what is happening.

By the end of 1932 they were bidding quite actively for business. Most municipalities, for purchases over $500, are required to advertise for bids, and usually they receive competitive prices for smaller purchases where more than one company handles the product. Now that several companies are submitting prices when bids are asked by the municipalities, it has become essential for the qualities of the material to be specified.

Some Means of Evaluating Carbon Is Essential.—Specifications must state how the carbon is to be evaluated, otherwise the purchaser has no assurance that it will be the best for the price paid. The importance of this has become more urgent due to some of the carbons being offered having fairly low adsorptive capacity. The low adsorptive carbons are cheaper to manufacture, and usually are offered at a lower price than that of the highly active materials. This leaves the purchaser in the position of not knowing which material to select.

In the September, 1932, issue of WATER WORKS AND SEWERAGE, the writer suggested specifications for powdered carbon based upon the phenol adsorption of the carbon. Several cities have purchased carbon based upon the phenol adsorption, but specifications defining the adsorption requirements of carbon are not in general use at the present time. Instead of trying to use specifications for purchasing carbon, some of the water purification chemists seem to be contented with criticizing any attempt to evaluate such materials. In the January issue of this magazine, Howard states: "J. R. Baylis endeavored to evaluate carbon by its ability to remove phenol from water. Unfortunately, this only furnishes information on this particular type of taste forming substance, and the experience of the city of Saginaw, Mich., indicated the test to be of limited value." In the March issue, Flentje states: "In the writer's opinion it would be a mistake, at the present time, to set up some single arbitrary laboratory method and attempt to correlate field data with that alone." It is believed that Howard misinterpreted the situation at Saginaw, and that Flentje relied upon inconclusive evidence.

There is every reason to believe that the phenol test gives good evaluation of carbons for the removal of tastes and odors from water, and this applies to Saginaw as well as to all other cities. Comparative tests of several grades of carbon on the Saginaw water will be given in this article. The writer has considerable evidence based upon carefully conducted tests that the phenol test does give a good evaluation of carbons for removing tastes and odors from water, and he is not aware of evidence to the contrary which is based upon properly conducted tests. The phenol test requires considerable time, and the work must be done accurately, but it requires nothing especially difficult for the water chemist. The portions of water treated with varying amounts of carbon must be stirred, filtered, portions of the samples distilled, certain reagents added to the distillates, and the color developed compared with the color of standards containing known quantities of phenol. There is nothing unusual or difficult about such procedures.

The writer recently attended the meeting of the American Chemical Society in Washington, D. C. Methods of testing carbon were discussed in several papers presented before the Water, Sewage and Sanitation Division. No one offered evidence that the phenol test was unreliable, but some stated that it was difficult to make. The idea of some of the water chemists seemed to be that chemical tests must be so simple that chemists are not needed to make the tests. Presumably when the chemists have finished developing tests so simple that they are no longer needed to make the tests they will take up some other line of work or move over the hill to the poor house.

Complicated tests are not advocated where simple tests will meet the needs, but if there is no simple test available and there is a test not very complicated it should not be rejected just because the test cannot be conducted within a few minutes by the average worker in water purification plants. The writer has asked some of those who oppose the suggested specifications how they would evaluate carbon. The reply has been that they do not have a test to offer. Perfection is not claimed for the suggested specifications, and improvements no doubt will be made. It is quite probable that some compound other than phenol will be substituted for the adsorption test when more data are available. There probably are a number of compounds which would be suitable, but either they cannot be determined accurately in very low quantities, or the procedure for conducting the test is just as complicated as the phenol test. The thing of greatest importance at the present time is to purchase carbon on the basis of its power to remove objectionable tastes and odors from water. Laboratory tests are satisfactory for evaluating carbons and are more accurate than plant tests when properly conducted. Carbon must eventually be purchased on the basis of laboratory tests.

A Knowledge of Adsorption Is Essential to Understand the Characteristics of Carbon.—With the possible exception of chlorinous tastes and odors, the removal of substances producing objectionable tastes and odors from water with carbon is by adsorption of the substances on the surfaces of the carbon. To understand what takes place one must be familiar with the theories of adsorption and also with the factors which influence adsorption. There is nothing about the adsorption of phenol, or the adsorption of nearly all other substances from water by carbon which is contrary to well known adsorption rules. Some compounds are adsorbed to a much greater extent than others, yet this does not prevent comparing carbons on the basis of its adsorption of some definite compound.

If a certain amount of phenol is adsorbed per gram of carbon, there may be some other compound in which only one-fourth as much is adsorbed as is the case for phenol. Another grade of carbon which adsorbs one-half as much phenol as the first carbon very likely will adsorb only one-fourth as much of the other compound as it adsorbed of phenol. In other words, the phenol adsorption ratio of the two carbons will be the same as the ratio of adsorption of the other compound. There may be slight deviations from this rule, but the deviations are not believed to be of any material consequence for the organic compounds usually causing tastes and odors in water.

There is ample evidence in the chemical literature to show conclusively that the adsorption of phenol from solution by carbon is in accord with the theory of adsorption. The writer has made, or has had made numerous tests showing that the adsorption of phenol is in accordance with what should be expected. Then why should it not be a good compound for testing activated carbon One advantage of phenol over many other compounds is that it can be determined in extremely minute quantities. If we knew the chemical structure of every compound in water responsible for tastes and odors, it does not seem probable that any other compound would be more suitable for testing carbon than phenol. Since we know practically none of these compounds, it is difficult to understand why so many hesitate to evaluate carbon on the basis of some compound which we do know. The theory of adsorption is correct and can be substantiated by experiments on numerous compounds, and the physical chemists feel confident that the main factors influencing adsorption are now fairly well understood.

Experimental Data Are Available.—Several chemists have stated that they do not favor the phenol test because the writer has not shown by actual experiments that it gives a good evaluation of carbon for removing objectionable tastes and odors from water. This compound would not have been selected without considerable evidence that it was suitable for testing carbon. It was not realized that it would be necessary to submit the actual experiments to convince others. It was thought just so long as it was shown that phenol adsorption was in accordance with the rules of adsorption this would be sufficient. Now that this is being given as a reason for doubting the reliability of the phenol test, some of the experimental data will be given. It would require entirely too much space to include in this article all the data which the writer has obtained experimentally. About 15 tests similar to the one which is given have been conducted. Certainly this is enough to include a variety of taste and odor producing compounds. Before giving the experimental data it is believed advisable to stress the importance of more research work on carbon and state how it is believed that this can best be brought about.

Much Research On Carbon Is Needed.—Even though there are now several highly active carbons on the market, it is believed that these materials can be made still more active. To do this will require much more research on carbon, and the expense of this research will fall largely upon those manufacturing carbon, for most improvement will be made in the manufacture and not in the application of the material to the water. There, of course, is need for much work on the part of the water works in the most economical use of the material. The writer is of the opinion that it would be better to have a few large companies manufacturing activated carbon than to have a number of small companies struggling for business. The large companies will maintain research organizations if there is sufficient business to justify such organizations, but there is no inducement to invest a large sum in research and then have to compete with smaller companies which expect to make no such investment. It is not known how the field can be limited to the large companies, but it is believed that the immediate use of specifications requiring high grades of material will discourage some from entering the field.

It is believed that far more will be gained by having a few large companies constantly striving to improve their products than to have a number of small companies trying to sell their products regardless of quality. The writer would prefer to see considerable sums being spent on research at the present time than the same amount being spent on high-pressure salesmanship, in which every time the water works purchases carbon they will have to listen to the merits of the particular brand the salesman is handling and the demerits of the other brands. One prospective purchaser recently said he had listened to so much of the demerits of the other companies' products from all of the salesmen that he had come to the conclusion that none of the carbons were any good.

Carbons Are 20 Per Cent More Adsorptive Than in 1931.—As an illustration of the benefit of research in carbon manufacture, the materials now being sold by the leading manufacturers of activated carbon are fully 20 per cent more adsorptive than the materials sold in 1931. When the writer in 1932 suggested specifications for powdered carbon based upon phenol adsorption, the average of the best grades of carbon then being offered

required 35 parts per million of the carbon to reduce the phenol in solution from 0.10 to 0.01 p.p.m. Now it requires only 27 to 28 parts per million to give the same phenol reduction. At the same time there has been a reduction in the price of the material, which of course might be attributed largely to market conditions. The increase in adsorption, however, has not been accompanied by an increase in the price. When methods of evaluating carbon were suggested the leading manufacturers began to try out the test and to see if improvements could be made in their products with the results which have been stated. Already these companies have invested much in research, and are willing to invest a great deal more if they are not subjected to unjust competition. The water works are profiting to the extent of having 20 per cent more adsorptive materials, and we may expect still more improvement in the quality of carbon if proper inducement for more research is given by the water works.

Comparison of Carbons on the Basis of Their Phenol Adsorption

It has been stated that the writer proposed the phenol test as a means of evaluating carbons after a number of experiments showed that it gave a very good indication of the suitability of the carbon for removing tastes and odors from water. As the water works are more concerned in the evaluation of powdered carbon at the present time than the granular materials, only the procedure for conducting laboratory tests on powdered carbon will be given.

Procedure for Testing Powdered Carbon.—This applies to materials which are added to the water in the form of a very fine powder and are later filtered out.

Varying amounts of the powdered carbon are added to two-liter portions of water containing 0.10 p.p.m. of phenol. At least one portion of the carbon should reduce the phenol to less than 0.01 p.p.m., and there should be two or more tests in which the phenol remaining in solution is greater than 0.01 p.p.m. If 30 to 40 p.p.m. of the carbon are required to reduce the phenol to 0.01 p.p.m.; 0, 10, 20, 30, 40 and 50 p.p.m. of carbon give points that will produce a very good curve. Stir the mixtures for two hours, and filter enough of the sample for a phenol test through filter paper. Test for residual phenol. (There is some doubt about two hours stirring being the most suitable stirring period. Some are of the opinion that a shorter period followed by a period of standing would be more typical of plant conditions.)

Plot the results of the phenol tests on co-ordinate paper, using parts per million of residual phenol for one axis and parts per million of carbon for the other axis. Draw a curved line to pass through most of the points. The parts per million of carbon required to reduce the phenol from 0.10 to 0.01 p.p.m. is called the "phenol value." It is found where the curve crosses the line of 0.01 p.p.m. of phenol remaining in solution. Logarithmic paper may be used and may be preferred by many.

Procedure for Conducting Comparison Tests on Odor Removal with Carbon

When several carbons are to be compared, usually the phenol values are determined, and the carbons used in proportion to their phenol values. It is not necessary to use the carbon in proportion of their phenol values, but if the phenol test gives a true evaluation of the carbons the materials should give equal taste and odor reduction when used in this proportion. By conducting a series of tests at the same time when using quantities of the carbon which will give equal phenol reduction, it is possible to compare the odor which remains in the portions of water after the test more accurately than if each solution contained a different intensity of odor. In this manner slight variations in the intensity of the odor can be detected; whereas if the tests are made at different times, or the carbons are not used in proportion to their phenol values, slight differences in the intensity of the odor cannot be evaluated properly. This, however, should not affect the threshold number determined by dilution with odor-free water. The procedure for conducting the test is as follows:

The desired amounts of the carbons are added to portions of the water upon which the tests are to be made, the mixtures are stirred for one hour, and then filtered through plugs of absorbent cotton packed in the bottom of glass funnels. The cotton plugs are first washed thoroughly with odor-free water, then about 200 cc. each of the solutions containing the carbons are filtered through the cotton plugs and discarded. It is difficult to wash filter paper thorough enough to prevent it imparting a slight odor to the water, but well washed cotton usually does not impart any odor. About 500 to 800 cc. of each of the samples should be filtered for testing purposes. This is usually sufficient for making all of the dilution tests required to find the threshold point.

Five hundred cc. flasks are used, and the amount of solution added to each flask is 250 cc. This makes the flasks nearly one-half full of water. Tests are first made on each of the portions of filtrate without dilution, then other tests are made on 125 cc. each of the filtrates and 125 cc. of odor-free water for 1-1 dilutions, 83⅓ cc. of the filtrates and 166⅔ cc. of odor-free water for the 1-2 dilutions, and so on for the various dilutions. The cold odor tests are made on the solutions at 20 to 25° C., then they are heated to approximately 70° C. for the hot odor tests. This is about the highest temperature which may be used without cooling the gases before inhaling. It is high enough for most odors, but there are a few cases where it is desirable to heat to a higher temperature. The procedure for making odor tests at higher temperatures was described by the writer in the December, 1932, issue of this magazine. It is evident the flasks must be covered or loosely stoppered while the solution is being heated to prevent escape of some of the odor.

When ready for making the odor test, the flask is agitated violently for about 5 to 10 seconds so as to bring the air within the flask in very close contact with the water. The air within the flask is conveyed to the nostrils through a glass nose-piece about ⅞-inch inside diameter and about 7 inches long, made especially to fit the nose of the person making the test. The nose-piece also was described and illustrated in the December issue of this magazine. The nose-piece gives very much more sensitive detection of the odor than the procedure given in Standard Methods of Water Analysis. The odor-free water is prepared by passing clear filtered water through a deep bed of granular activated carbon at a fairly slow rate.

The threshold number is one more than the dilution at which the odor is just detectable. To illustrate, if no odor is detected when the water without dilution is tested, the threshold is recorded zero, but if odor is detected without dilution and is not detected upon dilution, it is recorded 1.0. Odor detected with a dilution of 1-1 (a mixture containing 50 per cent of the filtrate and 50 per cent of the odor-free water) but not detected with a higher dilution is recorded 2. If the threshold point is at a dilution of one to five-tenths (approximately 67 per cent of the filtrate and 33 per cent of the odor-free water) the threshold number is 1.5. Likewise, if the dilution is 1-60, the threshold number is 61.

It is very important to keep the nose-piece clean, and there will be less adsorption on the surface of the glass if it is kept submerged in water when not in use. Frequent washing with soap and water is helpful. A very good procedure for making the hot odor test is to have a 500 cc. flask filled to approximately 250 cc. with odor free water. The water should be at approximately the same temperature as the sample to be tested. First shake the flask containing the odor-free water, and inhale the air through the nose-piece. Again shake and inhale from the odor-free flask. Sometimes a slight odor is noticed the first time the nose-piece is used after standing a short time. This is especially true for the hot odor. This may be due to adsorbed gases on the surface of the glass being driven off by the warm moist air. Almost invariably there is no odor the second time the warm air is drawn through the nose-piece. Proceed immediately to the sample to be tested.

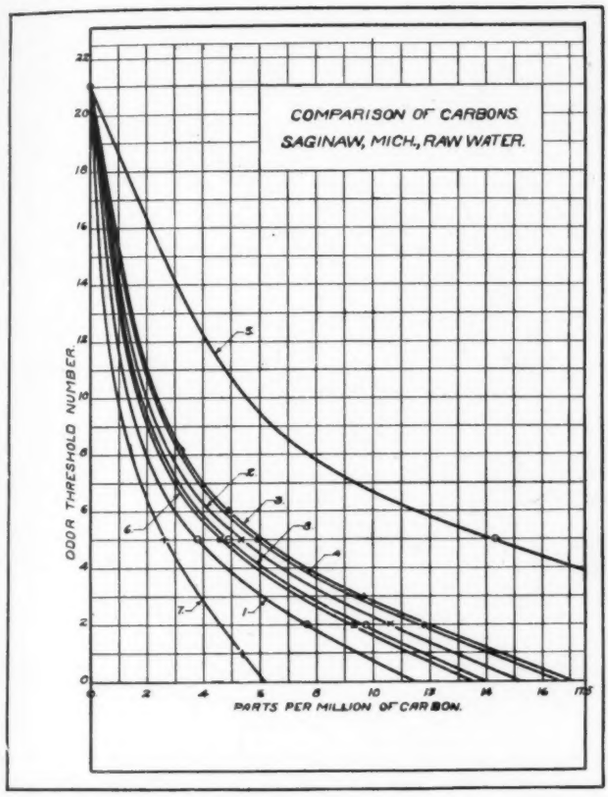


Fig. 1.—Comparison of Carbons in Saginaw, Mich., Raw Water

When the flasks are shaken thoroughly to mix the air and water, there is 250 to 300 cc. of air in the flask which has been brought in very close contact with the water. By inserting the end of the nose-piece nearly to the water the air taken into the nostrils receives practically no dilution from the surrounding air. Where a number of odor tests are to be made it is better not to make the tests so rapidly as to cause odor fatigue. The sense of smell is quickly fatigued by some odors. Usually smelling the air from an odor-free flask between each test sensitizes the olfactory nerves. By exercising extreme care in making odor tests, accurate results may be obtained by the procedure outline. Odor tests made by the procedure outlined in Standard Methods of Water Analysis are so inaccurate they are almost of no value for comparisons, and often lead to erroneous conclusions. This is largely why such widely varying opinions are being formed in regards to the qualities of some of the grades of carbon, and in regards to methods of testing.

Comparison of Carbons on the Saginaw, Michigan, Raw Water.—Since the Saginaw water has been mentioned as one of the waters in which the phenol test is of limited value, a series of tests on this water will be given to show that the test does give results in proportion to the phenol test. Carbon 3 shows a slight deviation from that indicated by the phenol value, but the deviation is so slight it is of no significance. In practically all other tests this carbon has shown no deviation from that indicated by the phenol value. The results of the tests are shown in Table I, and the threshold numbers are plotted on Fig. 1.

The amounts of carbon used for making the tests were varied in the ratio of the amounts required to reduce the phenol in solution from 0.10 to 0.01 p.p.m. One series of tests was run on the basis of 5.0 p.p.m. of a standard carbon requiring 35 p.p.m. of carbon to produce the stated phenol reduction, and the other series was run on the basis of 10.0 p.p.m. The amounts of carbon required for equaling the 5.0 p.p.m. of standard carbon were determined by multiplying the phenol values by 5.0 and dividing by 35, and the amounts for 10.0 p.p.m. were determined by multiplying the phenol values by 10.0 and dividing by 35. The tests were made in accordance with the procedure which has been given.

TABLE I—COMPARISON OF CARBONS ON THE SAGINAW, MICHIGAN, WATER

Phenol Values of the Carbons

Carbon No.	Phenol Value
1	26.5
2	37.0
3	34.0
4	41.5
5	100.0+
6	32.5
7	18.5
8	34.0

Carbon Used	Dilution	Odor Cold 20°C.	Odor Hot 70°C.	Threshold Number Cold	Hot
	0	2-se	4-se		
	1-1	1-se	3-se		
	1-2	1-e	3-se		
	1-3	0	3-se		
No Carbon	1-4	0	3-se		
Used	1-5		3-se		
	1-6		2-se		
	1-8		2-se		
	1-10		1-se		
	1-15		1-se		
	1-20		1-e		
	1-25		0	3	21
	5.0 *Parts Per Million of Standard Carbon*				
	0	1-s	3-s		
Carbon No. 1	1-1	1-s	2-s		
(3.8 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		0	2	5
	0	1-s	3-s		
Carbon No. 2	1-1	1-s	2-s		
(5.3 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		0	2	5
	0	1-s	3-s		
Carbon No. 3	1-1	1-s	2-s		
(4.9 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		1-s	2	6
	1-6		0		
	0	1-s	3-s		
Carbon No. 4	1-1	1-s	2-s		
(5.9 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		0	2	5

	Dilution	Odor Cold 20°C.	Odor Hot 70°C.	Threshold Number Cold	Hot
	0	1-s	3-s		
Carbon No. 5	1-1	1-s	2-s		
(14.3 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		0	2	5
	0	1-s	3-s		
Carbon No. 6	1-1	1-s	2-s		
(4.6 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		0	2	5
	0	1-s	3-s		
Carbon No. 7	1-1	1-s	2-s		
(2.6 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		0	2	5
	0	1-s	3-s		
Carbon No. 8	1-1	1-s	2-s		
(4.9 p.p.m.)	1-2	0	2-s		
	1-3	0	1-s		
	1-4		1-s		
	1-5		0	2	5
10.0 *Parts Per Million of Standard Carbon*					
	0	0	2-s		
Carbon No. 1	1-1	0	1s		
(7.6 p.p.m.)	1-2		0	0	2
	0	0	2-s		
Carbon No. 2	1-1	0	1-s		
(10.6 p.p.m.)	1-2	0	0	0	2
	0	1-s	2-s		
Carbon No. 3	1-1	0	2-s		
(9.7 p.p.m.)	1-2	0	1-s		
	1-3	0	0	1	3
	0	0	2-s		
Carbon No. 4	1-1	0	1-s		
(11.8 p.p.m.)	1-2		0	0	2
	0	1-s	2-s		
Carbon No. 5	1-1	0	2-s		
(28.8 p.p.m.)	1-2	0	1-s		
	1-3		0	1	3
	0	0	2-s		
Carbon No. 6	1-1	0	1-s		
(9.3 p.p.m.)	1-2		0	0	2
Carbon No. 7	0	0	2-s		
(5.3 p.p.m.)	1-1	0	0	0	1
	0	0	2-s		
Carbon No. 8	1-1	0	1-s		
(9.7 p.p.m.)	1-2		0	0	2

s Swamp
e Earthy

0 No odor
1 Very faint
2 Faint
3 Distinct
4 Strong

Tests for Carbon Should Be Based Upon the Amount Required to Give a Definite Reduction of the Compound Used For the Test.—Some have attempted to test carbons by adding a definite amount of the carbon to a certain concentration of some compound such as phenol or iodine. The mixture is agitated for a definite time, the carbon filtered out, and the solution tested for the amount of the compound remaining in solution. This does not give a fair evaluation of the material. It tends to penalize the more adsorptive materials by showing a higher adsorption for the poorer materials than their power to remove objectionable substances from water. It has been stated that the writer suggested that the comparison be based upon the amount of carbon necessary to reduce the phenol in solution from 0.10 to 0.01 p.p.m., a reduction of 90 per cent. Some other percentage reduction might be just as good, but *it is essential that the carbons be compared on the basis of the amount of the carbon required to give equal reduction of some certain compound* and *not on percentage reductions procured from definite amounts of carbon.*

The Iodine Test Will Not Be Discussed.—The writer is aware that the iodine test has possibilities of being suitable for testing carbon, but so far no one has developed an iodine test which gives accurate evaluation of the carbons. It may be used for an approximate test, and additional work may show it to be accurate enough for practical uses, but the writer does not believe it can be made as accurate as the phenol test. If the iodine test is used, it should be used in a manner similar to that suggested for the phenol test; that is, the results should be based upon the amount of carbon required to give a definite iodine reduction.

Association Meetings Scheduled

June 9-10—New York Sewage Works Association. Hotel Powers, Rochester, N. Y. Secretary, A. S. Bedell, care State Dept. of Health, Albany, N. Y.

June 12-16—53rd Annual Convention of the American Water Works Association. Hotel Sherman, Chicago, Ill. Secretary, B. C. Little, 29 West 39th Street, New York, N. Y.

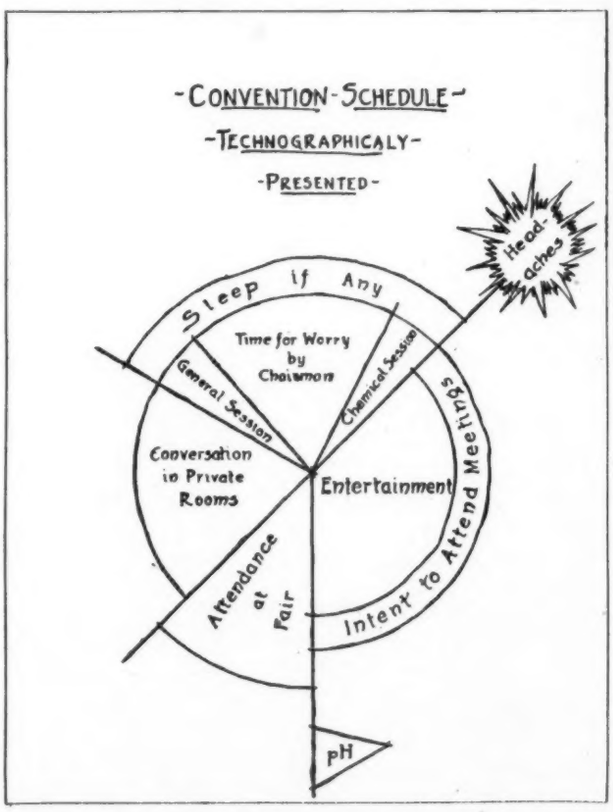
June 21-22—Illinois Association of Sanitation Districts. Galesburg, Ill. Secretary, G. H. Radebaugh, Mgr., Urbana Sanitation District, Urbana, Ill.

June 26-30—American Society of Testing Materials. Chicago, Ill. Secretary, C. L. Warwick, 1315 Spruce Street, Philadelphia, Pa.

June 27-30—American Society Civil Engineers. Chicago, Ill. Secretary, George T. Seabury, 33 West 39th Street, New York City, N. Y.

***June — — —Virginia Water and Sewage Works Association.** Newport News, Va. Secretary, H. W. Snidow, care State Dept. of Health, Richmond, Va.

Sept.—Central States Section American Water Works Association. Hotel Pantlind, Grand Rapids, Mich. Secretary, B. J. Lechmer, City Water Commission, Erie, Pa. (Date not announced.)



At the Close of the Last Meeting of the Committee on Publication and Program of the A. W. W. A., the Above Diagram Was Found on the Table—Suspiciously Near the Chair Occupied by One A. T. Clark, of Greenwich, Conn.

ORGANIC IRON AND COLOR REMOVAL FACILITATED BY USE OF PERMANGANATE

By THOMAS R. McCREA*
Rahway, N. J.

THE city of Elizabeth City, N. C., is located on the banks of the Pasquotank river, in Pasquotank County, which is in a section known historically as the Albemarle. It has a population of twelve thousand, the larger part of which are dependent on agriculture. There are also some industrial plants which contribute to its economical welfare, these being three hosiery mills, one cotton mill, cotton seed oil mill, lumber plants and the like. In years past it was a city of some export trade before the larger power driven vessels commanded the shipping. The sailing vessels filled their tanks with the dark colored water from the adjacent streams because of its favorable keeping qualities.

The swamplands have always afforded the only source of drinking water, except for private rain water cisterns, shallow wells and pitcher pumps. As the city and its industries grew, the demand for a municipal water system became paramount. In 1927 the city built a modern $235,000 filter plant, having a capacity of two million gallons per day, that supplanted an old antiquated plant that had been built some years before.

From the time this new plant was built, until May, 1930, the water from the Dismal Swamp lands was relatively low in color, varying from 150 to 550 parts per million. In 1929 when the writer assumed charge of the filter plant, the double coagulation process was being used. This process makes use of chlorinated-copperas (ferrous sulphate oxidized with chlorine) applied at the influent end of the mixing chamber, followed later by a dose of alum and lime, or aluminate of soda applied at the half way point of the mixing chamber. The primary coagulation was produced at a pH of 4.2 to 4.7 and the secondary coagulation at a pH of 5.5 to 5.8. The combination was capable of effecting a color reduction from a maximum of 550 parts per million in the raw water to about 10 parts per million in the finished water. The process afforded a decided advantage over any other, or the use of any other group of coagulants that had been studied up to that time.

The foregoing method of treatment, however, had some shortcomings when used in coagulating water which we consider as being in the lower color ranges. At times the filter effluent contained a residual color of about 10 parts per million, which was intensified about four times following alkali addition to the filtered water to raise the pH value. This residual color, increasing with increased alkali addition, was found to be the alpha group of soluble humins derived from swamps. These compounds possessed the property of causing a precipitate of a reddish brown coating on metallic iron whenever it was brought in contact with it—in water mains for example.

Further, the practical absence of turbidity in the raw water caused the floc to settle so slowly that the plant could operate only to a maximum of 75 per cent of its capacity. Then again the settled floc in the coagulation basins had a tendency to disintegrate suddenly after standing from 7 to 21 days, giving up with intensity the color previously precipitated, which necessitated immediate dumping of the coagulation basins. Apparently the floc was not "fixed," that is to say it was not sufficiently oxidized to render it stable.

*Formerly chemist in charge, filtration plant, Elizabeth City, N. C.

Difficulties Created by High Color

The chief short coming of the chlorinated-copperas, alum and lime treatment made itself evident when the extreme drouth of 1930 caused the raw water to show a color content much above the previous 150 to 550 parts per million. This extreme dry weather and high summer temperature resulted in a marked concentration of organic products as well as color which ran as high as 900 parts per million. So acute was this drouth that the Pasquotank river and Knobbs creek, the source of supply, ceased to flow and remained in a stagnant condition for many weeks.

Along with this highly colored water there appeared soluble organic bound ferric iron which proved not to be susceptible to removal by the coagulants and therefore passed through the filter plant undiminished. It

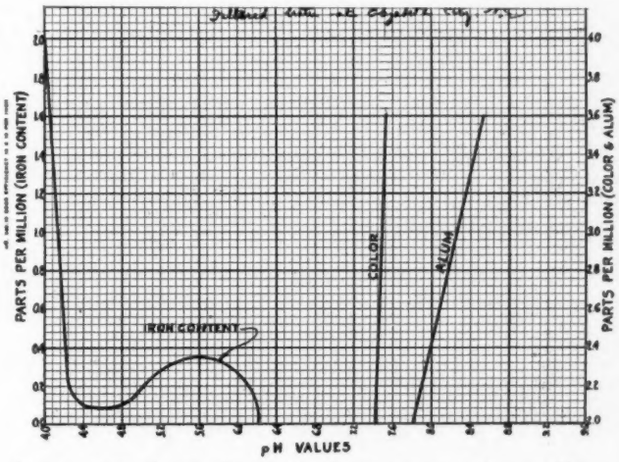


Fig. 1—Experiments Employing Permanganate. Curves Showing Effect of pH on Residual Iron, Color and Alum in the Filtered Water at Elizabeth City, N. C.

was shown also that this complex iron was of the alpha humins classification, as was true of the residual color remaining in the effluent.

Technical literature, generally, states that iron found in water of relatively high organic content is in combination with humic acid. This iron, however, was shown to be other than humic acid bound, for if it were so bound it would hydrolyze to produce hydrous ferric oxides within the range pH 4.2 to 6.2 wherein humic acid itself precipitates even though iron be bound to it.

Laboratory Studies

During a period of many months a series of laboratory investigations were carried on, centering on the utilization of potassium permanganate to arrest and coagulate the alpha humins group. These studies were made on the lower color range before the organic bound iron made itself evident in the highly colored water that accompanied the drouth. The analysis of the raw water studied in the laboratory indicated the following characteristics.

pH	5.6 p.p.m.
Alkalinity	18.0 p.p.m.
Iron	2.0 p.p.m.
Soap hardness	30.0 p.p.m.
Turbidity	8.0 p.p.m.
Carbon dioxide	20.0 p.p.m.
Color	300.0 p.p.m.

The accompanying graph (Fig. 1) deals with this water of low color and consequently the results are slightly different from the more favorable results obtained during the actual plant operation when treating water in the color range from 550 to 900 parts per million. The filter plant effluent was negative in iron content and in residual manganese. The alum content of the filter effluent was negative in the laboratory experiments and showed but slightly more than a trace in the plant effluent.

In the laboratory it was found that the minimum dose of potassium permanganate required to effectively treat this water was 0.25 grains per gallon. This quantity was sufficient to attack the alpha humins group, though it did not come near satisfying the potassium permanganate demand exhibited by the water. The experimental dose in the laboratory was: Lime 20 parts per million, chlorinated-copperas three grains per gallon, and alum two grains per gallon. The potassium permanganate was applied to the raw water immediately following the line. The chlorinated-copperas and alum followed in succession.

Plant Scale Treatment

The plant scale operation was planned and executed as follows: A cylindrical steel tank, three and one-half feet in diameter and of an equal depth was set up on top of the influent end of the mixing chamber at a point indicated by (A) in the photograph showing the rear view of the plant. A fairly concentrated solution of potassium permanganate was made up in the tank, and a known volume of the permanganate solution was delivered through a petcock so as to effect a dosage of 0.25 grains per gallon. Lime immediately preceded the potassium permanganate in order to produce the required pH value 8.8 to 9.8 wherein the permanganate efficiently precipitates and arrests the alpha humins group. Fortunately the laboratory studies were completed and the plant apparatus set up for operation on the morning that we were confronted with a raw water of extremely high color content with organic bound iron present to the extent of 5 parts per million. The results were successful and no color or iron passed through the plant.

The above mentioned pH of 8.8 to 9.8 was used only for the purpose of arresting the alpha humins group, and later at the mid point of the mixing chamber chlorinated-copperas and alum were applied, resulting in a pH of 5.8. However, after the water passed the filters, secondary lime or caustic soda could be applied to bring the water to a pH of 6.8 to 7.4 without return of color.

Advantages Gained

By the use of potassium permanganate as the primary treatment in the high pH range, many difficulties of plant operation and many disadvantages in control of filter effluent were overcome. Important among them was the fact that there was no return of color when the secondary alkali dosage was applied. There was produced a comparatively rapid settling flocculent precipitate which permitted the plant to operate efficiently at 90 to 100 per cent of its capacity.

With this treatment the coagulated material in the settling basins showed little or no tendency to disintegrate or peptize. At times when the raw water possessed a color of 600 p.p.m. the settling basins were clear enough for the settled floc to be seen through a depth of 12 to 15 feet. The agglomerated floc was apparently "fixed" or properly oxidized and the water was delivered to the filters containing a negligible quantity of iron and color and no manganese.

Rear View Filtering Plant, Elizabeth City, N. C. Mixing Basin on Right Side of Coagulation Basin.

Discussion and Conclusions

In technical literature we find that the use of potassium permanganate for elimination of iron from water is recommended in those cases in which the iron is bound to organic substances with which it forms a stable compound which is not susceptible to hydrolysis. Hydrous ferric-oxide which under certain circumstances flocculates easily is therefore not formed in these solutions during aeration and the iron remains in the finished water, bound to the colloidal color. In this case potassium permanganate causes a decomposition of the ferric compound by oxidation of the organic "rest" so that the iron gets an opportunity to precipitate as the hydrous ferric oxide.

Water from the Great Dismal Swamp area of Pasquotank County, North Carolina, containing the highest color ever recorded in natural water, was successfully treated with potassium permanganate in small doses, supplementing the chlorinated-copperas treatment. Such treatment destroys color and organic bound iron, which results are not accomplished with any other group of coagulants. It is economical and practical.

This treatment will arrest color even in its highest ranges and will likewise arrest high concentrations of naturally occurring organic bound iron.

Potassium permanganate is most effective and less liable to produce a taste in the finished water if applied in the higher pH ranges—i. e., 8.8 to 9.8 wherein lies the iso-electric point of hydrated manganic-oxide [$MnO(OH)_2$].

▼

Birmingham's New Sewage Treatment Plant in Operation

The new 12 m.g.d. sewage treatment plant recently completed as a part of the Ensley project in Birmingham, Ala., has been placed in operation and the plant of the Bessemer project (16 m.g.d.) is nearing completion. The treatment at the latter plant will for the present consist of fine mechanical screening and chlorination. The Ensley plant consists of screening, grit, removal, sedimentation and separate sludge digestion.

H. H. Hendon, Sanitary Engineer of Jefferson County, has had charge of design and construction of the Birmingham sewerage improvements. Fuller and McClintock, Engineers, served as Consultants on both projects.

EDITORIALS

"By Prompt and Vigorous Action"

THE President of this United States has made unbelievable strides since March fourth in setting machinery going and to end the depression and remedy the unemployment situation in our country. In his latest move he has asked for prompt enactment of laws to govern industry, not alone in respect to increasing employment and regulation of wages, but also to protect industry. Much to the point, has been his request of Congress that the law be framed "to prevent unfair competition and disastrous over-production" and thereby make possible an increase in wages in regulated industries. As far as possible, it is proposed to regulate production, competition and wages through Trade Associations which will draw up agreements and codes (under government guidance) to be adhered to by competitor member corporations and therefrom insure fair competition without price fixing. Heretofore, Trade Associations and the somewhat less commercial institutes, like most other cooperative producing and marketing bodies, have not always been successful. This, for the reason that non-cooperating corporations have enjoyed the benefits of the Association actions without being bound to the acceptance of the restrictions placed on member corporations and, in consequence, the President offers a remedy to prevent this difficulty in his plan for regulating employment and competition. To preclude possible exploitation of the consumer he has at his command the, once useful, anti-trust laws to serve as a check-rein to possible price fixing and other unfair practices.

By such regulatory steps wasteful practices can be eliminated in the manufacture and marketing of basic commodities. The corrective measures proposed will benefit industry and thereby those employed by our industrial establishments. The employed, who are also the nation's consumers, along with the manufacturers constitute the taxpayers of the nation. The improved condition of each will lead to the payment of over-due taxes and thereby the ability of cities to go forward with necessary public works which the non-earning and low-earning taxpayer has forcefully objected to in recent years.

The President realizing "the gravity of the emergency" and that several steps were requisite before industrial improvement, taken alone, would bring about a revival of public works betterments, and to speed up employment from both ends at once, made a second and more immediately productive suggestion to Congress on May 17th. In this, he urged that "provisions should be made to permit states, counties and municipalities to undertake useful public works" requiring the expenditure of approximately $3,300,000,000 to be distributed by loan and grant from the federal government through a newly organized Federal Emergency Relief Administration rather than the Reconstruction Finance Corporation which has proved so disappointing to those expecting much of it.

These are the words of President Roosevelt which should make history: "We must, *by prompt and vigorous action,* override unnecessary obstructions which in the past have delayed the starting of public works programs," and he stresses the need for its accomplishment *"by simple, direct procedure."*

Probably before the type is set for this page the National Recovery Bill will have passed the Congress and have been signed by the President—making it immediately operative. The main feature of that part of the new bill pertaining to water works and sewerage is that the project does not have to be entirely self supporting before a loan or grant can be secured through the Administrator of Relief or the President himself and in the language of the bill—(Sect. 203)—"upon such terms as the President shall prescribe, to make grants to states, municipalities or other public bodies for the construction, repair, or improvement of any such project, but no such grant shall be in excess of 30 per cent of the cost of labor and materials employed upon such projects."

It is now planned to ear-mark $1,500,000,000 of the $3,300,000,000 for loans to municipalities for water works and sewerage betterments and an additional $500,000,000 is to be allocated to making direct grants, to serve as governmental aid in such projects, to the extent of 25 per cent of that borrowed. That is to say: a city receives an outright grant of $25 for every $75 borrowed for use on public works projects. Further than this, the President is now working on the problem of assistance to cities which are finding the procurement of ready cash and sales of its bonds difficult. With such assistance cities now unable to balance their budget will be able to do so and meet the requirements of the Act calling for a balanced municipal budget before loans and grants will be granted for public works construction.

The governmental assistance is in no sense a dole or charity measure and therefore normal planning and construction procedure is to be anticipated. To lend impetus to this nation-wide program, municipalities will find it also profitable to take advantage of the 25 per cent bonus which the law provides in the form of a grant and should not anticipate the difficulties previously encountered in procuring aid through the R. F. C. City authorities should be proud to go forward with the same *"prompt and vigorous action"* which is emanating from the White House and thus add force to the revival of trade and employment.

L. H. Enslow

For the Benefit of All—Start at Once

COMMUNITY cooperation with President Roosevelt and the present administration in Washington, in their courageous plan to put men back to work, will create throughout the nation structures for the benefit and use of all the people. None can be of greater usefulness than new and additional water works and sewerage. None can be more readily planned and placed under construction. None can be so easily made to pay its way in proportion to service rendered without adding to the present burdens upon real estate.

Start at once to prepare your contract plans and specifications for all needed water supply and sewerage facilities and be ready to furnish needed employment this summer on their construction. Thereby you and your neighbors will be joining forces with other communities in the great offensive against the depression and will create, in the space of a few months, works of permanent character which will raise materially the present standard of living. In helping to restore normal trade you will also improve health, provide conveniences and safeguard property.

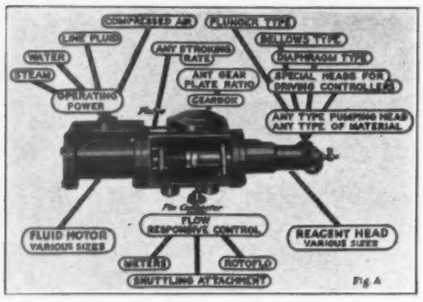
Malcolm Pirnie

NEW EQUIPMENT AND MATERIALS A REVIEW

On this and following pages are reviewed the more important developments in New Equipment and Materials which have appeared during 1932 and 1933. Some of the material has been reprinted from past issues of WATER WORKS & SEWERAGE for the purpose of having the items in this annual Water Works Convention issue.—Editor.

Tret-O-Unit: The Jig-Saw Puzzle of Water Works Equipment

It may be somewhat farfetched to compare %Proportioneers% Tret-O-Unit with the jig saw puzzle of present-day popularity



Tret-O-Unit

and interest, but there is a decided parallel none the less. Both consist essentially of a few basic parts which placed in proper relationship with one another form the complete assembly. There are five basic parts of the Tret-O-Unit—no more, no less—viz: gear box assembly, oscillating valve, impulse motor, yoke and reagent end. These fitted together in various ways form several devices for proportioning chemical solutions to liquids or for the control of pumping operations.

The assembly of gear box and oscillating valve with a flow responsive device at one location is capable of transmitting impulses to the impulse motor at a near or far removed point. The impulse motor in turn operating a solution pump delivers chemical reagents to the liquid being treated in direct proportion to the rate of flow.

Examination of the above illustration reveals the many possible combinations which can be built up from the component parts of the Tret-O-Unit and hence its jig-saw puzzle characteristics and variety of applications. The accompanying illustration shows the unit connected to the flow responsive Roto-Flo which can be placed in any pipe line conveying any nature of liquid. It is also adaptable to any ordinary meter.

The Tret-O-Unit is adaptable to feeding the most corrosive of chemicals such as chlorine and ferric chloride and also in the accurate sampling of liquids in proportion to the volume of flow. It will start, vary and stop treatment automatically without the attention of an operator and possesses features which make it worthy of consideration in a variety of problems.

For additional information, descriptive literature will be sent by %Proportioneers%, Inc., 737 N. Michigan Blvd., Chicago, Ill.

Tret-O Rotor

"Aloxite" Brand Air Diffusers for Sewage or Water Aeration

The Carborundum Company of Niagara Falls, N. Y., have developed the "Aloxite Brand" diffuser plates and tubes. "Aloxite" is fused crystalline aluminum. It is stated

"Aloxite" Brand Diffuser Plates and Tubes

that Aloxite Brand diffusers will furnish the smallest size bubbles, combined with the lowest pressure loss for any given capacity of any product on the market.

Aloxite Brand plates or tubes can be obtained with permeability ratings ranging from 4.0 cu. ft. per minute to 60.0 cu. ft. per minute (dry test under 2-in. water pressure). Standard size plates are 12x12x 1-in. and standard tubes are 24-in. long with a 3-in. internal diameter and ⅝-in. wall thickness.

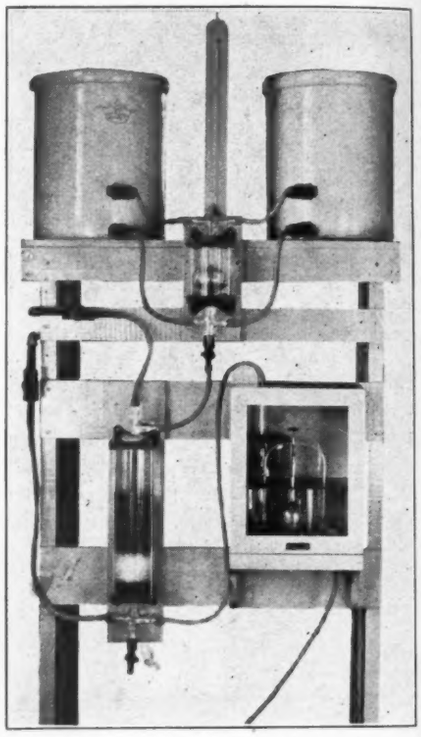
The Carborundum Company maintains a permanent research laboratory and a technical and sanitary engineering staff which are at the service of consulting engineers, city engineers or others interested in aeration problems.

Engineering Bulletin (No. 1) is worth writing for. Address The Carborundum Company, Niagara Falls, N. Y., attention Sanitary and Filtration Department.

Novel Solution Feed Equipment

Phipps & Bird, Inc., of Richmond, Va., developed a new device for feeding solutions at a constant rate.

The heart of the feeding device is a siphon mounted on a parallel motion hinge,



Phipps & Bird Solution Feed

the free end of which is carried on a float operating in the rectangular tank from which the solution is fed. The solution flows from the main supply tanks to the rectangular feeding tank under the control of a float valve, which throttles the inflow of solution to the rate at which the siphon is feeding. The rate of feed depends on the difference in level between the solution in the tank and the outlet end of the siphon.

The output of the siphon is caught in a glass vessel formed to serve as both a funnel and a trap. When the supply to the feeder is stopped, this trap seals the open end of the siphon and causes the siphon to be kept primed in readiness to commence feeding as soon as the supply to the apparatus is restored.

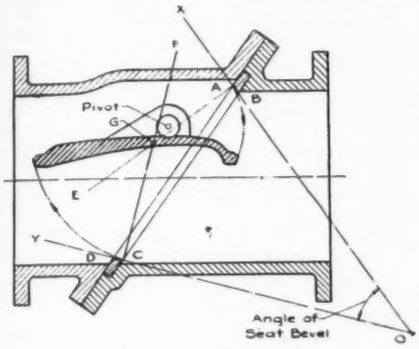
All parts of the apparatus can be dismantled for cleaning with no other tool than a screw driver.

There are two pieces of accessory apparatus that have been designed to work in conjunction with the feeder where required. One is an automatic valve for switching the feed from one solution supply tank to another when the first runs dry.

"Chapman" Tilting Disc Valves—A New Departure

The Chapman Valve Manufacturing Company of Indian Orchard, Mass., offers a radical departure in check valve construction which was designed so as to retain all desirable qualities of a check valve and eliminate the undesirable qualities inherent in check valves generally. This interesting new valve just placed on the market is known as the tilting disc valve. Its general principle of design and construction is indicated in the above illustration.

The rigid circular disc (G), of cast bronze or cast-steel, is dished and of "aerofoil" section to give maximum strength with minimum resistance to water flow



Sectional Sketch of Tilting Disc Valve

when the valve is in the open position as shown above. The disc rotates about fixed pivots, offset from the seat, and drops clearly into contact with the circular (bevelled) seat (A-D) without rubbing. The heart of the valve is the offset pivot so planned that the disc opens easily because of the almost equal balance about the pivot. In the open position the disc does not flutter and it closes quickly on cessation of flow to form a *drop-tight* contact with the seat.

The valve will not close with a bang because a cushioning effect is obtained by way of forcing the short "flap" of the disc against the flow of the stream which dampens out any tendency to slam on closing. Loss of head through the tilting disc valve is low because the effort to open the almost balanced disc and thereafter hold it open is very slight. The body of the valve is designed with clear lines throughout its interior.

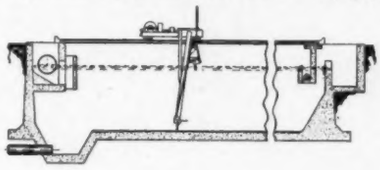
The same principle is applied to the new Chapman disc stop valves, manually or hydraulically operated. Write the Chapman Valve Mfg. Co. at Indian Orchard, Mass., for their new booklet, "Tilting Disc Valves."

Hardinge Rectangular Clarifier

The Hardinge Company of York, Pa., has recently perfected a sludge collecting mechanism of the crane type for use in rectangular shaped settling tanks. Several installations made to date have been very satisfactory from the standpoint of its operation and the clarity of overflow and removal of settled solids in the tank.

This equipment is automatic in operation and has no under water mechanism, and can be readily adapted to existing tanks. It is supplied for use in tanks from 15 ft. to 60 ft. wide and of a length up to 300 ft. A motor of 1 hp. capacity is sufficient to operate the average sized machine.

The Hardinge collector comes equipped



Hardinge Rectangular Clarifier

with skimmers for removal of floating material if so specified and is provided with safety devices for protection against overload or obstructions within the tank.

For more detail write the Hardinge Co., York, Pa., for literature describing this and other equipment used in water and sewage treatment.

National Carbide's Improved V-G Handy Light

The V-G handy light, distributed by the National Carbide Sales Corporation, Lincoln Bldg., New York City, has recently been improved and the base redesigned to improve stability and appearance.

This light has proven highly efficient and adaptable for emergency work by city water departments and other departments

V-G Handy Light

requiring a powerful light that is easily handled and carried about.

The V-G handy light weighs only 23 pounds when fully charged, and produces 1500 candle power for 5 hours on 1½ lbs. of National 14 N. D. (granulated) carbide.

As more than 75 per cent of its weight is on the bottom, it is not easily tipped over, but if overturned no harm is done and it will continue to operate satisfactorily if righted again.

Dresser Split Sleeves for Permanent Repair of Pipe Lines

The S. R. Dresser Mfg. Company, Bradford, Pa., has developed a new cast split sleeve, known as "Style 57," for the permanent repair of leaks, breaks and splits in the straight sections of cast-iron pipe. Permanent tightness is maintained by means of resilient rubber packing at the sides and ends, and it is no longer necessary to consider split sleeves as temporary installations.

The end-pack embodies the time-proved Dresser stuffing-box principle. The side-

Dresser Cast Split Sleeve, Style 57

pack, made with a rectangular gasket confined in a groove in the lower half of the sleeve, prevents gaskets from blowing out when installing under pressure. When two or more sleeves are to be connected, the joiner-pack consists of two end gaskets, plus an extra rectangular gasket, all confined by a band of stainless steel.

Installation of the new sleeves requires no special materials and equipment such as lead pots, caulking tools, runners, lead and yarn. A wrench tightens the bolts. Ordinary laborers can easily repair pipe in a wet ditch or even under water. Before shipment, each sleeve is tested to withstand a hydrostatic pressure of 500 pounds per square inch.

The single-unit sleeve has an inside clearance of 8¼ ins. between end gaskets. Two or more units may be jointed together by the use of simple joiner parts. The sleeves are available for A. W. W. A. classes A, B, C and D cast-iron pipe in sizes 3 in. to 12 in. inclusive. Vents vary in size according to the size of the sleeve.

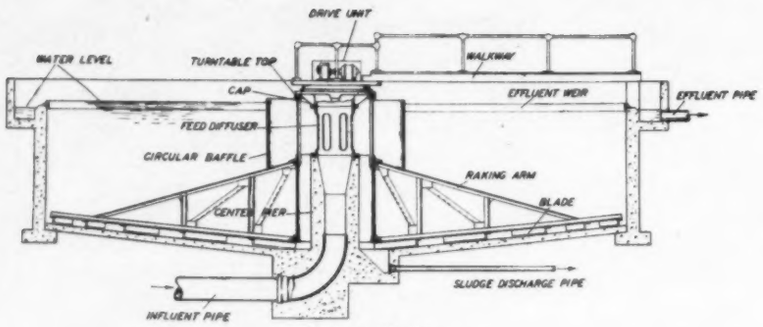
Sleeves to be used for connecting up small laterals or services to mains can be furnished with a blind boss (no vent) to be drilled and tapped as used, or with a standard vent that can be reduced to the proper size by means of a bushing. For additional information, address S. R. Dresser Mfg. Company, Water Works Division, Bradford, Pa.

Dorrco Developments

During 1932 and 1933 The Dorr Company, Inc., have been very active in developing new types of clarifiers, digesters, aerators and distributors for the sewage treatment field, and new types of chemical mixers and flocculators for the water treatment field.

The Dorr Sifeed Clarifier—The distinctive features of the new Dorr Sifeed Clarifier are, first, the introducing of the influent through a centrally located, inverted siphon with special feed diffuser; second, the overflowing of the clarifier effluent across a continuous peripheral weir extending around the entire inside of the tank at the water level.

By introducing the feed centrally, through a submerged and inverted siphon with special provision for radial diffusion,



Sifeed Clarifier

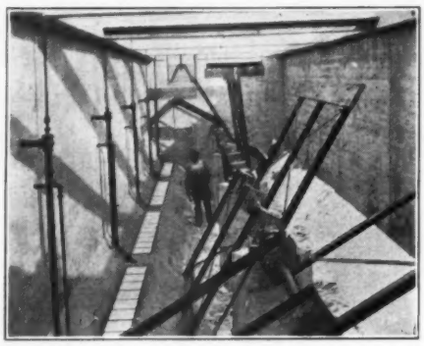
the following operating advantages are claimed: The head of water above the diffusing casting exerts a dampening effect preventing turbulence and agitation at the center and giving a better control of feed distribution. A substantial saving in head is secured and frequently a saving in the cost of the tank itself, due to the elimination of accessory channels. The collecting of the clarified effluent over a peripheral weir of maximum length induces a progressive decelleration from influent to effluent with the rate of flow reaching the absolute minimum in the immediate vicinity of the overflow weir. Reported tests indicate that volume for volume, the new Sifeed Clarifier either gives a greater capacity than the older "cross-flow" clarifiers (based on the same percentage removal of suspended solids) or else under identical conditions of volume of flow and retention period produces higher efficiency in terms of solids removed.

The Type K Sludge Digester—An important feature of the new Dorr Type K Digester is the complete elimination of the heavy bridge type superstructure which formerly spanned the tank, and the substitution therefore of a central column and radial structural members for supporting the revolving mechanism and the flat, concrete cover. As a result, the new unit is attractive in appearance and requires no special housing for the drive unit.

Type K Dorr Digesters at Birmingham, Ala.

Both the sludge and scum breaking arms are attached to a central steel drum concentric with the supporting concrete center column, which is supported from a turntable on top of the same column. The mechanism is driven by enclosed type motor and speed reducer covered by a weatherproof case.

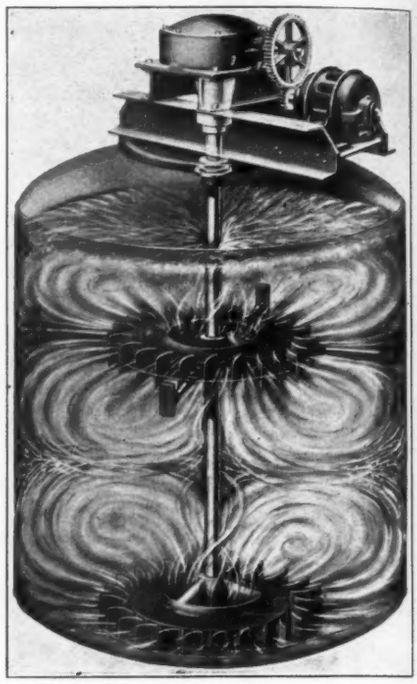
The upper end of the concrete supporting column terminates in a heavy, cast iron spider provided with a multiplicity of radial arms from which vertical rods are hung. Each vertical rod supports the inboard end of one of the many radial eyebeams which carry the weight of the superimposed concrete cover.



Dorrco Sewage Aerator at Escanaba, Mich.

The Dorrco Sewage Aerator—The Dorrco Aerator, one of the most important developments of the Dorr Co., is of the combined mechanical and diffused air type and is distinctive in that the rotary motion of the sewage induced by motor driven paddles operates in a direction counter current to that of the upward flow set up by the rising bubbles of diffused air.

By driving the paddles downward against—not upward with—the stream of rising air bubbles, the period of contact between air and sewage is increased. The air is distributed across the complete width of the tank and the amount of air required to secure a definite biological result is thereby reduced materially and therewith the cost of treatment. The Dorrco Aerator operates with only 0.3 cu. ft. of air per gallon and a total power input of 15 to 18 hp., divided almost equally between compressing the air and revolving the paddles.

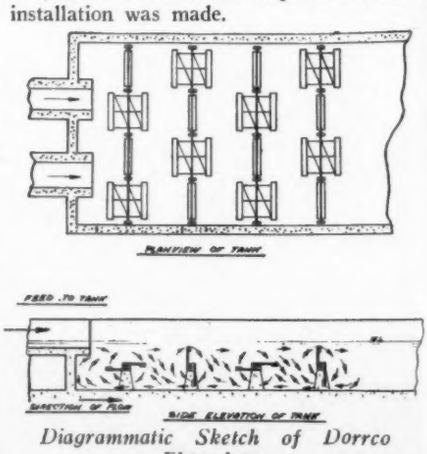


Dorrco Flash Mixer

Of the 25 installations made to date, the largest is at Phoenix, Ariz.

The Dorrco Flash Mixer—The Dorrco Flash Mixer, a modification of the Turbo Mixer, is used for intimately and instantaneously diffusing coagulating or softening chemical reagents throughout the liquid being treated. A special form of turbine impeller operating within a stationary diffuser ring provides quick intimate mixing. The unit consists of three parts—a tank or container of any convenient shape or size, a high-speed mixing mechanism and a motor drive unit. The raw water and chemicals are drawn into the centers of the impellers and when discharged tangentially are deflected into straight, radial lines by the curved stationary blades.

The Durrco Flocculator—The Durrco Flocculator was developed in collaboration with Mr. M. C. Smith of the Richmond, Va., water works at whose plant the initial installation was made.



Diagrammatic Sketch of Dorrco Flocculator

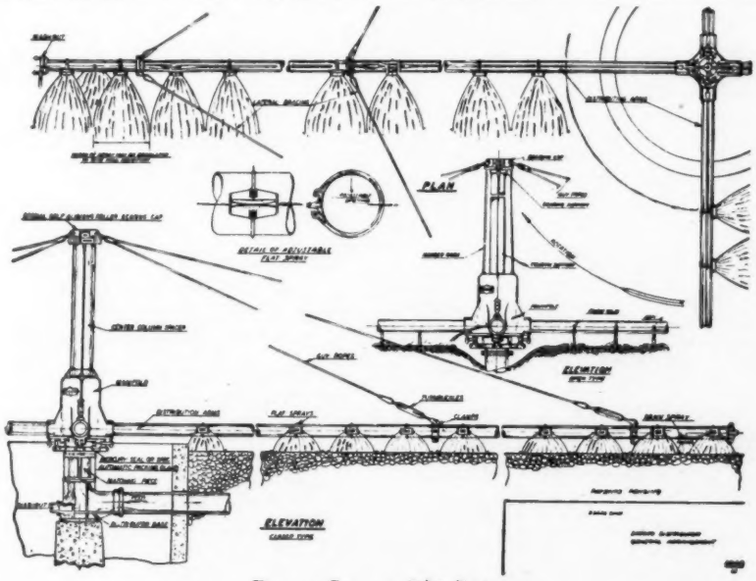
The Dorrco Flocculator consists of a number of large radius paddles rotating about a horizontal axis and installed at the influent end of rectangular sedimentation tanks with the axis of rotation at right angles to the direction of flow.

The shaft is supported between paddles by bearings resting upon concrete or steel columns and is driven by a variable speed motor and speed reducer.

The shafts of the Flocculator rotate in unison and in the same direction, being inter-connected by chains and sprockets and driven from a single drive unit. The paddle blades of multiple units are of such decreasing widths as to provide a progressive diminution in the intensity of agitation as the water passes through the unit.

In practice the paddles keep the flocs in suspension during formation and circulate them gently throughout all parts of the water so that they may absorb and entrap the fine suspended solids and color particles. A reverse current in the bottom of the basin, also induced by the paddles, causes a certain proportion of the large flocs to be returned to the inlet end of the basin where they are mixed with the incoming water and act as nuclei for the building up of additional flocs. Eight months' operation at Richmond, Va., at a rate of 30 m. g. d. resulted in a saving of 4,000 lbs. alum per day, twice the former settling rate, a 12 per cent longer filter run and a power consumption of only 6 K. W. H. per M. G.

The Dorrco Sewage Distributor—The Dorrco Sewage Distributor is of the self-propelled revolving type and operates without outside power under hydraulic heads as low as 12 ins. It is used for applying settled sewage evenly over circular, trickling filter beds. The most important feature of the Dorroco Distributor is the use of special flat spray nozzles, from which the sewage issues as a thin sheet, fan-like in shape. These nozzles may be adjusted readily to give almost any shape or thickness of sewage spray and due to their staggered positions on the rotating arms, their sprays wet overlapping areas, thus assuring complete utilization of the surface of the bed at each revolution.



Dorrco Sewage Distributor

Crane Improved Globe Valves

Crane Company of Chicago, along with other improved equipment, has recently offered an improved type of brass globe valve designated as the 212 P valve and an angle valve designated as the 214 P valve.

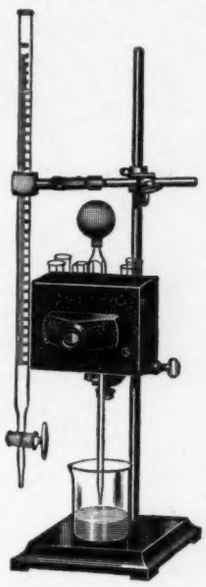
Crane Globe Valve

These valves have the Crane union-type of bonnet, as pictured, which makes for greater ease in dismantling and re-assembly and the bonnet union ring absorbs all strain or stress which might otherwise reach the bonnet joint and cause leakage. The bonnet ring is made of a special Crane hard metal (copper and tin alloy) which has great strength. The stuffing boxes are unusually large and are filled with high-grade asbestos ring packing. An interesting feature is that these valves may be safely repacked when wide open and under full pressure. The non-rigid, positive swivel disc-stem connection prevents the disc from turning on the seat and thus precludes possible injury of the seat by closing and opening operations.

The 212 P and 214 P valves have the plug type seat and disc and are thereby especially well suited for severe service and refinement in regulating flows by throttling. The wide seating contact precludes the likelihood of injury from "wire-drawing" of foreign matter which tends to destroy the seat bearing and create leaky valves. This type of construction insures the tightness of these valves for a much longer period than those having the conventional type disc construction. The disc is of Crane nickel alloy and the seat ring is made of Exelloy.

Hellige Titration Comparators

Hellige, Inc., 179 E. 87th St., New York City, have added to their varied equipment a titration comparator which now makes it simple to determine the acid or alkali required to raise or lower the pH value of liquids to a predetermined and definite point without the use of complicated electrometric outfits. Essentially, the determination entails an ordinary titration of a sample of the material. The end-point is determined by comparing the pH value of the titrated liquid with standards at intervals. Until the end-point is reached the portion of sample being tested for pH value is returned each time to the titration beaker and therefore no correction for the "take out" is required.



Titration Comparators

The pH comparator in this assembly is the well-known pocket type of Hellige comparators, and those already possessing such can order the supplemental parts to make up a tritration comparator set.

American Electro-Magnetic Chemical-Feed Controller

The American Water Softener Company of Philadelphia, Pa., have developed an ingenuous automatic chemical feed control scheme involving the use of an electro-magnet and mercury switch in conjunction with a water meter.

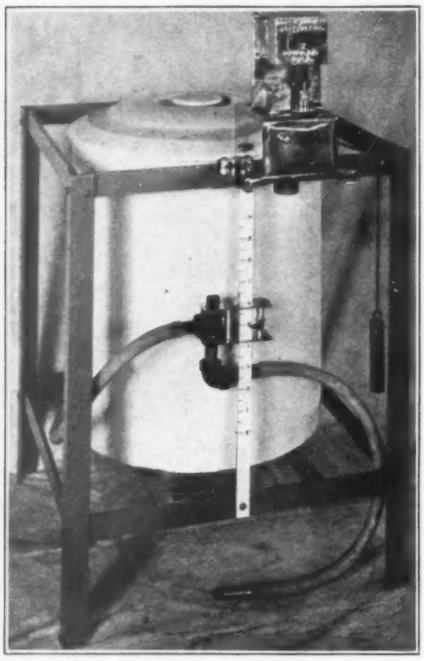
The water to be treated passes through the meter, which is provided with gears so that for every certain number of gallons passing (the exact number being dependent upon the amount of the flow) the mercury switch makes and breaks an electrical circuit through the electro-magnetic proportioner. As the circuit is closed by the mercury switch, the powerful electro-magnet of the electro-magnetic proportioner is energized pulling up the armature of the magnet and rotating the control sprocket on the outside of the proportioner a slight amount through the ratchet and pawl combination with worm gear transmission.

Over the control sprocket of the proportioner passes a chain fastened to hinged swivel take-off pipe in the chemical tank which is lowered as the control sprocket rotates. The large unrestricted opening of the swivel take-off pipe is at the surface of the chemical solution at all times and the solution is skimmed off the top through this opening. It then flows by gravity through the swivel take-off pipe and either

flows or is pumped to the point of application.

Inasmuch as the proportioner is operated from the water meter, which furnishes the impulses in proportion to the water flowing, the swiveled take-off pipe is lowered in direct proportion to the water flowing and the chemical is thus fed proportionately.

The amount of chemical fed is varied without changing the strength of the chemical solution by screwing up or down the



The Electro-Magnetic Proportioner Serves for the Smallest to the Larger Feeding Operations.

vernier adjustment of the electro-magnetic proportioner. Screwing down the vernier adjustment means increasing the length of stroke and therefore, increasing the chemical feed, whereas screwing up the adjustment means correspondingly a decrease in the chemical feed until at the very top-point no stroke whatever of the solenoid is obtained and consequently no chemical is fed.

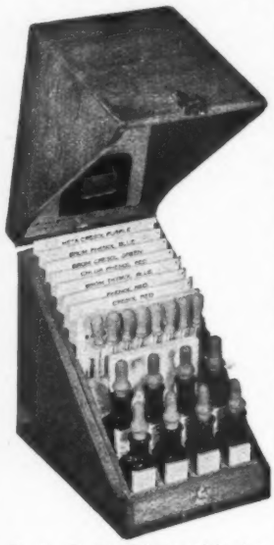
The operation of the proportioner and swivel take-off pipe is the same no matter what kind of chemical is to be fed, except that if the chemical is in suspension, an agitating equipment is provided in the chemical tank to prevent the chemical from setting out.

When it is desired to feed chemicals at a constant rate, the electro-magnetic chemical feed is used in exactly the same way as when proportional feed is desired, except that a synchronous motor is used to operate the mercoid switch in place of the water meter. The vernier adjustment of the proportioner can be used for the constant rate feed in exactly the same manner as for the proportionate feed permitting feeds of chemicals from nothing up to many times the maximum required.

For literature describing this ingenuous device address the American Water Softener Co., 4th and Lehigh, Philadelphia, Pa.

S.D.C. Residual Chlorine Tester

Pascher and Betzold, 829 Orleans St., Chicago, offers the S. D. C. residual chlorine tester. It is packed in a wooden cabinet which measures 4⅛ ins. high, 2¼ ins. deep and 5¾ ins. wide. Top consists of seven color standard tubes covering a range of 0 to 1 part per million of residual chlorine. The tubes are numbered as follows: 0, .2, .4, .6, .8 and 1 part per million. They are mounted on a slotted chalk white card 5 ins. wide and 3 ins. high. A compensator, used for comparing colored or turbid solutions, and correcting the color standard when substances which react with ortho tolidine are present, is attached to the card when used. A dropping bottle of ortho tolidine reagent, three large pipettes for making comparisons, a porcelain mixing plate and a dilution pipette which in conjunction with a large pipette permits a dilution of ten to one, are also included.

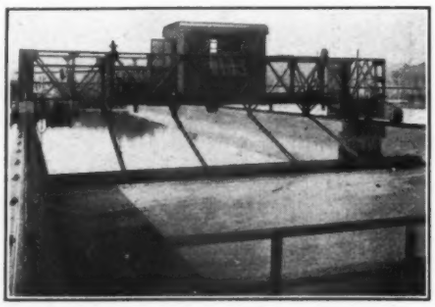


S. D. S. Residual Chlorine Tester

This device was originally developed in the laboratories of the Sanitary District of Chicago, for which the initials S. D. C. stand.

New Link-Belt Sewage Treatment Equipment

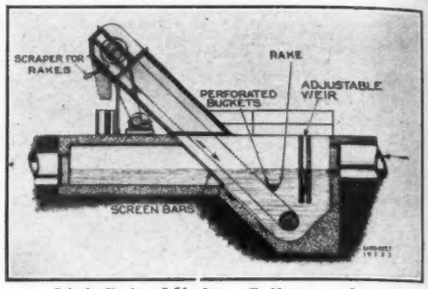
Type "C" Sewage Screen—The Link-Belt straightline type "C" screen is a combined bar screen and grit chamber, especially designed for use at medium and small size plants, where the cost of separate mechanically cleaned units might be prohibitive. It is adapted for continuous or intermittent operation.



Link-Belt Type "C" Straightline Screen—a Combined Bar Screen and Grit Chamber.

Its main elements consist of a hopper, a bar screen with approximately 1-in. openings, and a bucket elevator for the dual service of removing the grit from the hopper, and cleaning the bar screen.

Regulation of the currents through the hopper is made by two baffle plates near the influent end, one adjustable downward and the other upward, to permit settling of the grit, and prevent settling of the organic matter. The upper baffle allows part of the flow to pass over it.



Link-Belt Mieder Collector for Removing Sludge from Primary Settling Tanks.

The lips of the elevator buckets are provided with rake teeth, which engage with and clean the screen bars on their downward travel. The buckets are perforated, permitting the water to drain out while they carry the grit and other accumulations up to discharge into a suitable container or trough for removal.

Mieder Sludge Collector—Link-Belt has acquired the patent rights for the sale and construction in the United States of the Mieder collector for the removal of sludge from primary settling tanks. This device consists of a traveling bridge to which is hinged a deep scraper. This scraper moves the sludge which has settled on the bottom of the tank, towards the influent end, where it is withdrawn. On the return run the scraper is raised to the position shown in illustration, and used for skimming the surface of the liquid in the tank. One collector can serve a large plant, because it can be transferred from one tank to another.

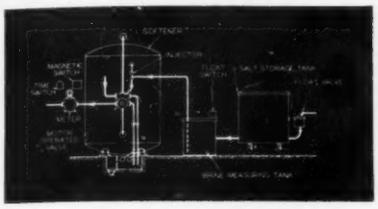
All of the driving machinery is located on the bridge, out of the sewage, and the scraper can be inspected whenever it is raised to the surface. The machine is operated by one man, and combines large capacity with low-cost operation. One scraper serves two tanks of the Elizabeth, N. J., plant.

Fully Automatic Water Softener Developed by Permutit

A new fully automatic zeolite water softener has just been announced by The Permutit Company, 440 Fourth Ave., New York. This softener eliminates the errors due to the human element and conducts all of the operations of softening and regeneration with machine-like regularity and precision.

By a clever combination of a meter operated switch and electric controls with a motor-driven Permutit single valve, each operation of the water softener is conducted under such precise control that the highest efficiency results. Briefly, at the end of the softening run, the meter actuates the electrical control which carry through the

steps of (1) Cutting the softener out of operation. (2) Backwashing it for a regulated period so as to secure thorough cleansing. (3) Admitting a carefully regulated amount of saturated salt brine so as to assure thorough regeneration without wastage of salt. (Rinsing out the calcium and magnesium (hardness) salts and excess sodium (regenerating) salts to waste with the minimum amount of rinse water.) And



Automatic Zeolite Water Softener.

(4) throwing the softener back into service, thus placing it again under control of the meter, which governs the volume of water to be softened during the softening run and initiates the start of the next regenerating cycle.

All new models may be had in the full automatic type and it is a relatively simple matter to apply the automatic control to any existing softeners, thus converting manual to fully automatic operation.

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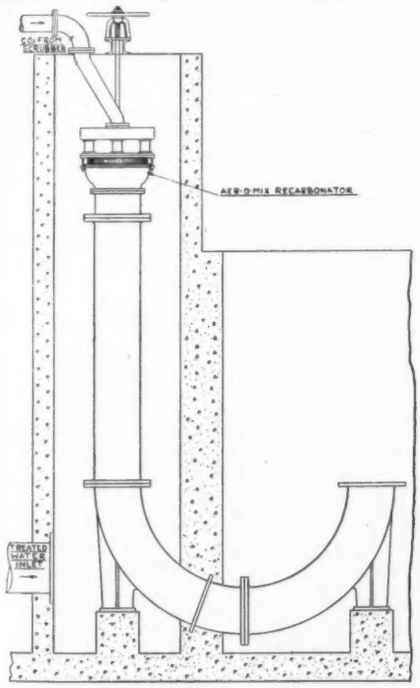
"Aer-O-Mix" Recarbonator

The new water softening plant recently completed at Ottumwa, Iowa, contains three 8 mgd. Vogt Bros. Aer-O-Mix units, one is for combined aeration and mixing of coagulant as the raw water enters the plant,



"Aer-O-Mix" Recarbonator

a second is for recarbonation, and a third is for final pH and taste control after recarbonation and filtration.

The Aer-O-Mix Recarbonator operates on the same principle as the aeration Aer-O-Mix carbon-dioxide gas instead of air being aspirated as the water flows through the throat. This eliminates the use of a blower or compressor for the CO_2 gas and the grid pipe diffuser system. The gas is drawn directly from the scrubber to the Aer-O-Mix head by the normal pull of the Aer-O-Mix. The water passing through the Aer-O-Mix comes in intimate contact with the CO_2 in the down-pipe and upon release numberless small bubbles of gas rise to the surface of the basin. This system of recarbonation produces uniform gas diffusion and the intimate contact needed for effective recarbonation.

For further details covering the operation of the Aer-O-Mix Recarbonator address Vogt Bros. Mfg. Co., 14th and Main St., Louisville, Ky.

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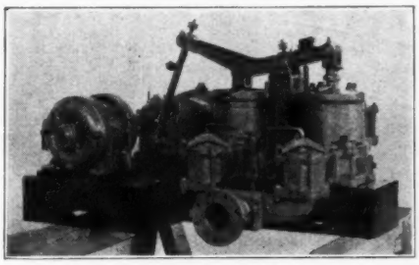
Chain Belt's Rex Sludge Pumps

The Chain Belt Co. of Milwaukee, Wis., have perfected the Rex Sludge Pump as an additional piece of equipment added to their line of diaphragm pumps and other sewage plant appurtenances. These pumps are of the plunger type—single or double plunger styles being available as stationary or portable units. These pumps are used for handling raw digested sludges, activated sludge or humus from secondary tanks. They are capable of pumping with a 25 foot suction lift and discharging against a head of 65 feet. Capacities are



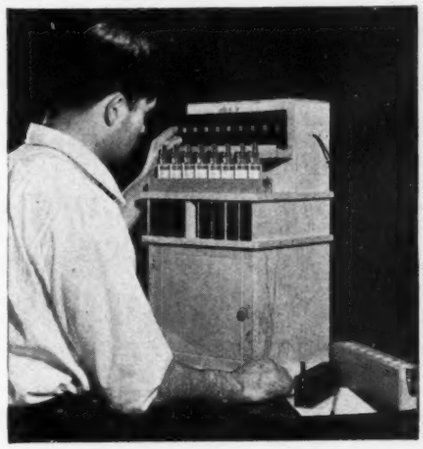
Rex Double Plunger Sludge Pump, Multi-Speed Motor and Speed Reducer Equipped

75 gallons per minute for the single and 150 gallons per minute for the double plunger units. Standard units come equipped with multi-speed motors and herringbone-gear speed reducers equipped with Timken bearings. Stroke of plunger is adjustable to secure 3, 4 or 5 inch displacement. The walking-beam drive employed means long life of pump because there is practically no side thrust to create wear on plunger and cylinder. With flap type valves a clear opening of four inches through the entire pump is had which reduces possibility of clogging to a minimum. The valve cases are equipped with quick removable covers. Another unique feature of the pump is that the packing is in the plunger instead of the cylinder wall. With the several speeds and three variable stroke adjustments, the ratio of minimum to maximum capacities is one to six. Heavy construction is used throughout, making the pump a very sturdy unit. For more detailed information write the Chain Belt Co. (Division of Sanitation Equipment), Milwaukee, Wis.

Taylor Dalite Slide Comparator

In many cases it is necessary to make pH or residual chlorine determinations at night. Also in many plants even during the day time the light is not suitable for this type of work. The use of ordinary electric light bulbs and even the so-called dalite bulbs is not satisfactory.

The development of the Taylor Dalite slide comparator by W. A. Taylor & Co., 872 Linden Ave., Baltimore, Md., enables the worker not only to make determinations at night with just as great accuracy as dur-



Taylor Dalite Comparator

ing the day but also assures him that measurements made at night will check those made on the same materials by ordinary daylight.

The pH equipment supplied with this set consists of one complete slide comparator with from 2 to 7 additional color standard slides, vials containing the corresponding indicator solutions with pipettes and nipples, and 10-5 cc. test tubes. Each slide contains nine color standards for any given indicator and these slides fit in slots in front of the case as shown in the illustration above. Each vial of indicator solution is placed directly above the corresponding color standard slide, thus eliminating error due to the use of the wrong indicator solutions. A cover protects the vials when the set is not in use.

The comparator base is supported by a shelf on the front of the box. Directly behind the slots in the base is a piece of dalite glass and in the compartment behind this is a 25 watt electric light bulb, with cord, switch and socket. In the lower part of the box is a cupboard of sufficient size to hold four 1000 cc. pyrex bottles. This cupboard not only serves as a storage for stock bottles of indicator solution but also brings the comparator to a convenient height for making readings. A rack on the inside of the door holds 10 5 cc. test tubes. A test tube brush is also supplied with the set.

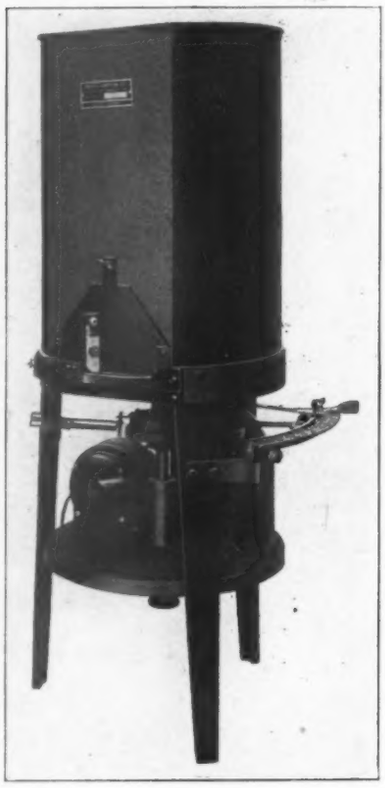
In making determinations three of the 5 cc. test tubes are filled to the mark with the solution to be tested, the proper color standard slide is placed on the base and 0.5 cc. of the corresponding indicator solution is added to the middle tube by means of the pipette and nipple. The light is then turned

on and the slide moved back and forth until a match is obtained with one of the color standards. The pH value is then read off directly from the values on the slide.

The set is supplied in 6 models, to provide the required number of standard slides.

Omega Dry Feeder

The new Model 1 dry feeder recently announced by the Omega Machine Company of Kansas City, Mo., has been designed primarily for the accurate feeding of small quantities of chemicals—notably activated carbon. Its range of feed lies between 1 and 200 pounds of material per 24 hours. The capacity of the feed hopper is 50 pounds of powdered activated carbon "Nuchar" or 150 pounds of hydrated lime. The new feeder is especially designed for accuracy at *all* rates of feed and is instantly adjustable to a different rate of feed without guess-work.



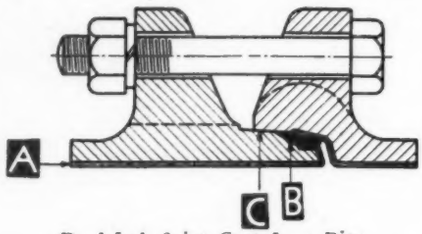
Model 1 Omega Disc Feeder.

The feeder is motivated by a ¼ H. P. motor turning a horizontal disc, at the bottom of the hopper, which has grooves in its face. The filled groove becomes exposed as it turns and at this point an adjustable scraper removes the material from the groove and allows it to drop into a solution or wetting chamber from which it is discharged continuously to the liquid being treated. More than 200 speed changes of the disc are available to vary the discharge of chemical at will.

Descriptive leaflets may be had by addressing the Omega Machine Company, 4010 Penn. Ave., Kansas City, Mo.

"Dual-Lok Joint" Cast Iron Pipe

The "Dual-Lok Joint" has been developed by the Central Foundry Company, makers of Universal pipe and fittings, to serve as a gas and air tight joint without losing the advantages of the universal type of joint. For lines carrying corrosive liquids, the gasket keeps the flexible joint protected against attack. The higher the pressure on the line the tighter the joint. The "Dual-Lok Joint" pipe in plain iron or cement lined is available in diameters 2 to 30 ins. in lengths of 6 ft. The joint is made up with a wrench for tightening just two bolts—no more. For carrying hot water and gas at sewage works "Dual-Lok Joint" is highly satisfactory—as it is for air lines and sprinkling filters.



Dual-Lok Joint Cast Iron Pipe.
A—Cement lining supplied when specified.
B—Non deteriorating gasket consisting of endless ring of specially developed composition.
C—Flexible iron to iron joint which cannot be affected by the liquid within the pipe.

The Central Foundry Company, 420 Lexington Ave., New York City, will send you descriptive literature covering this development.

Jeffrey Sewage Screens

For the two new activated sludge plants now under construction for the city of Lancaster, Pa., The Jeffrey Manufacturing Company, Columbus, Ohio, has designed four self-cleaning bar screens of a new type.

These new screens are provided with a special hinged scraper which prevents jamming of the mechanism due to the accumulation of foreign material in the bottom of the channel or upon the screen proper. The teeth of this special hinged scraper, acting as a comb, pass entirely through the bars of the screen, cleaning not only the surface but the space between the bars, thus eliminating grease accumulations.

The scraper mechanism on the new type Jeffrey screen descends in a runway somewhat removed from the screen, thus entering the sewage well away from the accumulated refuse. Upon reaching the bottom of the channel the scraper drags horizontally for a distance of approximately 2 ft. before reaching the screen. At this point is ascends with the teeth projecting entirely through the screens and, in this position, comes up under the floating refuse, carries it to the top, and discharges it into suitable receptacles. At the discharge point the scraper engages a wiper which removes any material that may adhere to it. This wiper, being counterbalanced, returns to its normal position after the scraper passes.

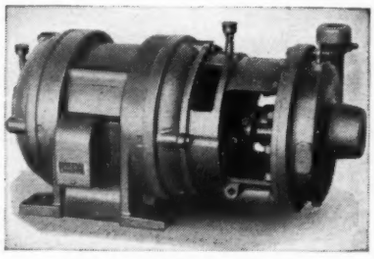
The control mechanism is such that the screens may be operated continuously or at intervals of every 2 seconds to once an hour, and if desired the screens may be furnished with a float control, automatically operating the mechanism at any selected loss of head through the screen.

Complete data covering this new type bar screen may be had by writing The Jeffrey Company, Columbus, Ohio.

Allis-Chalmers "SSU" Pumps

The Allis-Chalmers Mfg. Co. has recently extended its popular line of "SSU" motor driven single shaft, two bearing pumping units. They have now developed three sizes to work against heads up to 100 pounds (231 ft. head) and above and covering a range in capacity from 30 gallons per minute to 140 gallons per minute. These pumps fill the need for high head pumps of low capacities at low cost.

The pumps and motors (both Allis-Chalmers products) are properly proportioned so as to work together as an efficient reliable unit. A single shaft is used on which to mount the motor rotor and the pump impeller. This shaft being supported by two amply sized ball bearings does away with any possibility of misalignment between the pump and the motor.



Type "SSU" Pumping Unit

Toncan Sectional Plate Pipe

A recently developed product of the Toncan Culvert Manufacturers' Association, Youngstown, Ohio, is Toncan sectional plate pipe. The new product, which is a large diameter corrugated pipe for heavy duty drainage applications, is factory-fabricated from rust-resisting Toncan iron plates with standard 6-inch corrugations, 1½ inch deep. Diameters range from 60 to about 150 inches. Extra heavy galvaniz-

Fabricating Toncan Sectional Plate on the Job.

ing after fabrication assures maximum protection.

The plates are assembled on the job, making transportation easy, and loading

and unloading speedy. Since they are of uniform size, they may be nested on the truck or car, permitting transportation economies. The only materials required for erection are the plates and Toncan iron nuts and bolts. The plates are swung into place and immediately secured with the bolts which are easily placed, even by inexperienced workmen.

In addition to these refinements of design, Toncan sectional plate pipe possesses the high rust-resistance which is characteristic of the base metal from which it is made—Toncan copper molybdenum iron.

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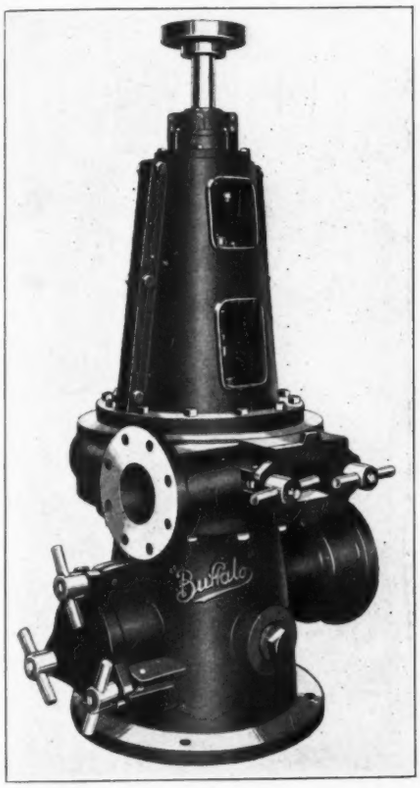
Buffalo Non-Clogging, Ball-Bearing Raw Sewage Pump

A new, non-clogging raw sewage pump, designed for economical operation, and equipped with ball bearings, is being manufactured by Buffalo Pumps, Inc., Buffalo, N. Y.

This model, made in a complete range of sizes, employs a non-clogging rotor of the same design as the standard Buffalo non-



Buffalo Non-Clogging Sewage Pump.

clogging sewage pump. There are no projecting surfaces and nothing to obstruct the flow of solids or foreign material. The impeller, of enclosed type, is regularly furnished of cast iron, but can be made of bronze or other metal on special order.

A cast iron superstructure, vertically split for easy assembling and dismantling, contains the bearings, which are mounted in individual cartridges. The upper ball bearing carries combined radial and thrust load, the lower bearing carries radial load only. Intermediate ball guide bearings are of self-aligning type. All bearings are so designed that moisture, dust and other foreign material are kept from them.

The pump casing of heavy cast-iron is provided with a casing ring to prevent wearing at the impeller inlet.

Provision is made for convenient lubrication of bearings, and inspection openings have quick-action covers.

Shaft is of steel, Monel or other metal, machined all over and attached to impeller with key and covered end lock nut. Coupling is flexible pin and rubber bushing, flanged type.

Because of production economies affected in designing, this pump sells at a lower price than the standard Buffalo non-clogging pump.

For further information address Buffalo Pumps, Inc., Buffalo, N. Y.

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New La Motte Equipment

The past year has witnessed several new developments in the research laboratory of the LaMotte Chemical Products Company of Baltimore, Md. The following are of particular interest:

1. The new combination swimming pool comparator set for accurately determining

Pool Comparator Set

the pH and residual chlorine content of swimming pool water has been offered. It is a single unit, combining the phenol red pH test set with the well-known LaMotte-Enslow chlorine comparator. Thus, a single outfit has been produced which adequately covers the needs of the swimming pool operator.

2. To make available to the water works profession even those tests which are infrequently used, equipment and reagents for residual alum and phenol tests in water have been produced. Special sealed Nessler tube standards and the LaMotte Nessler tube colorimeter have been developed for the residual alum test constitute a portable self-contained unit.

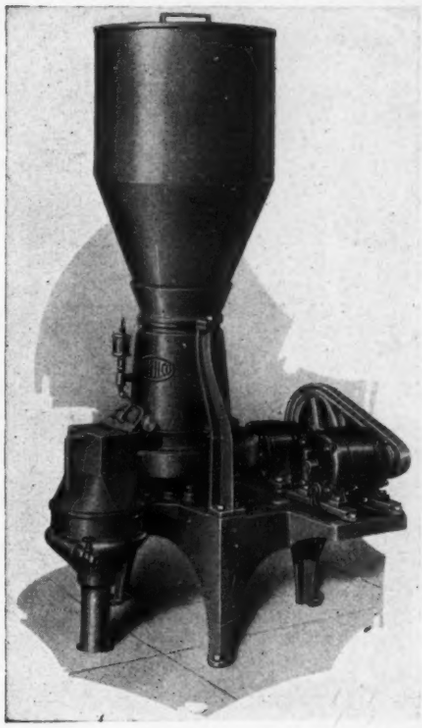
In the test for phenols by the Baylis modified procedure, special care has been given to the preparation of buffer mixtures and reagents required, including an exceptionally pure 2:6 dibromquinone-chlorimide reagent.

3. A new side-arm titration flask has been perfected which enables one to titrate to a definite endpoint without disturbing the contents of the flask. LaMotte standards are used for comparison purposes.

No. 8 Infilco Dry Feeder

The International Filter Company have made an addition to the line of "INFILCO" Dry Feeders.

The new feeder is designed to feed very small quantities of chemical with extreme accuracy—or it can be set to feed substantial amounts if so desired. It is prac-



"Infilco" Dry Feeder No. 8.

tically dust tight and the Vortex-Mixer supplied with it assures thorough and prompt wetting of such materials as the powdered carbons and other chemicals that tend to float. It also draws dust down into the discharge through the suction created by the vortex effect, thereby increasing the cleanliness of the operation. Powdered carbon can be fed at any rate between 1 ounce and 50 lbs. per hour; hydrated lime—from 2 ozs. to 100 lbs. per hour; alum—from 8 ozs. to 150 lbs. per hour.

Write International Filter Company, 59 E. Van Buren St., Chicago, Ill., for Bulletin No. 95.

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Screw-Feed Centrifugal Pump for Sludge

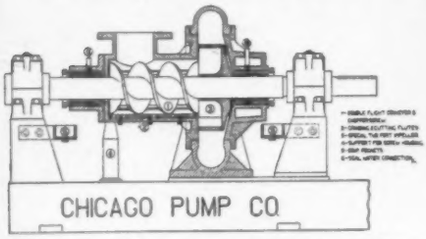
The Chicago Pump Company has recently developed an entirely new idea for the pumping of heavy sludge in sewage disposal plants or high consistency liquids in industrial processes.

The diagram shown on this page indicates the principle of this new pumping unit. Sludge or other heavy materials are conveyed to the pump by a conveyor and cutting screw. This screw is of the double-flight type and each passage in the screw connects with its own port in the impeller. In the screw housing are four hardened flutes. These flutes assist in guiding the

sludge to the impeller, and provide a cutting edge for the solids. Thus, the screw-feed design directs all articles through the pump on a continuous stream-line. It also breaks and cuts up anything that would otherwise be impossible to handle.

The unusual design in this pumping equipment facilitates the handling of primary sludge with a minimum amount of trouble. The principle has never before been used in sludge pumping.

The Chicago Pump Company has issued



The Screw-Feed Centrifugal Primary Sludge Pump, Developed by the Chicago Pump Co. (Patents Applied for)

a new bulletin No. 128-D describing their "Primary Sludge Pump." Copy may be had by writing to the company's offices at 2336 Wolfram St., Chicago.

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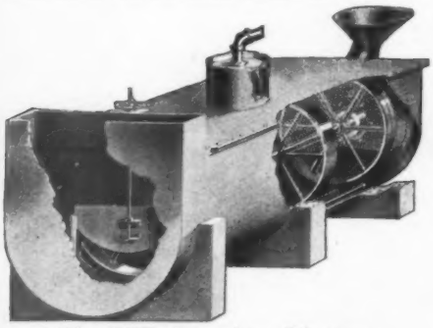
New Development of PFT

During the past year the Pacific Flush-Tank Company has made a number of improvements in their present equipment and, in addition, has brought out a number of new lines in the field of sewage and water treatment.

The most interesting among these is a new proportional flow tray clarifier for which the manufacturers claim a high percentage removal of suspended solids at very high rates.

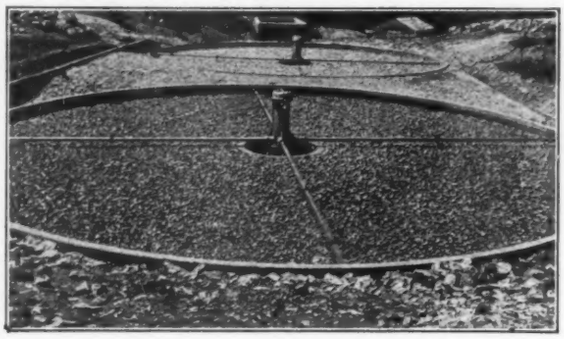
A number of improvements have been made in the Marlow sludge pump which has been handled by the PFT Company for many years. Besides the Simplex unit this pump is made in Duplex and Triplex types. The pump is now equipped with Hyatt roller bearings, adjustable eccentric with shear pin overload, intermediate gears



The PFT Screenings Digester

totally enclosed and running in oil, and driven through a V-belt or silent chain drive. This pump has shown its reliability in the handling of lime sludge in water softening and heavy gritty sludges from sewage treatment processes.

A unit specially designed to overcome the difficulties encountered in handling sewage screenings and similar wastes is shown in the accompanying cut. By this method it is possible to keep fibrous materials, which tend to float, in more intimate contact with the seeding material, thereby promoting more rapid digestion. The ar-



PFT Rotary Distributors at Butlerville, Ind.

rangement shown may be either placed in a concrete tank or supplied as a self-contained unit.

In addition to the well-known line of siphons and filter equipment supplied by the PFT Company since 1893 there is now offered a self-propelled rotary sewage distributor which will operate efficiently under very low heads. This machine embodies special features, allowing perfect adjustment after erection. A double roller bearing assembly keeps the machine in perfect alignment during operation. This results, it is stated, in a unit which will operate under lower heads giving more uniform speeds of rotation and consequent better distribution.

The PFT Company has issued bulletins describing the above equipment which give interesting data pertaining to sewage and water treatment. Address Pacific Flush-Tank Company, 4241 Ravenswood Avenue, Chicago, or 136 Liberty Street, New York City, for your copies of any of these bulletins.

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Warren-Knight Transit-Level

To meet the demand for a moderate priced instrument for use around a water works or sewerage plant, where a precision transit is not necessary the Warren-Knight Co., Philadelphia, Pa., have developed a new transit-level.

Warren-Knight Transit Level

This instrument is built to meet all requirements of every day instrument work at a price to conform to present-day budgets. It is of entirely new design, with new optical system and new dual bearing standards, an exclusive feature which enables the adjustments of the telescope and level to be checked as easily and in the same way as an ordinary wye level. It is an accurate, dependable, compact instrument, conveniently packed in a substantial hardwood carrying case, complete wtih trivet pins, plumb bob, reading glass, sunshade and tripod. Some of the main features follow:

As easily and quickly adjusted as a wye level; has a maximum tilt of 110 deg.; the protected horizontal circle has a vernier reading to single minutes; the telescope, with level attached, is provided with clamp and tangent for quickly and accurately taking level readings; the telescope has a magnifying power of 22 diameters and the 120 deg. vertical arc, with clamp and tangent, makes it easy to run levels or measure vertical angles.

Write for catalog WW-76 for further details.

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WITH THE MANUFACTURERS

"One-Fifth Century of Progress in Chlorination"

The Wallace and Tiernan Company exhibit at the A. W. W. A. Convention in Chicago will feature "One-Fifth Century of Progress in Chlorination." The developments in chlorinating equipment during the past 20 years will show the very first chlorinator built and installed by the Messrs. Wallace and Tiernan at the Boonton Reservoir of the Jersey City Water Works. The evolution in chlorinators on exhibit will bring the story up to date, showing the most recent chlorinator development of the Wallace and Tiernan Company—the "Monitor."

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The new office building of the Worthington Pump and Machinery Corporation, situated adjacent to the corporation's plant at Harrison, N. J., was opened May first. The general and executive offices, formerly situated at 2 Park Ave., New York, have been moved to the new location for better co-ordination with manufacturing and sales operations. The local sales office will be continued at 2 Park Ave.

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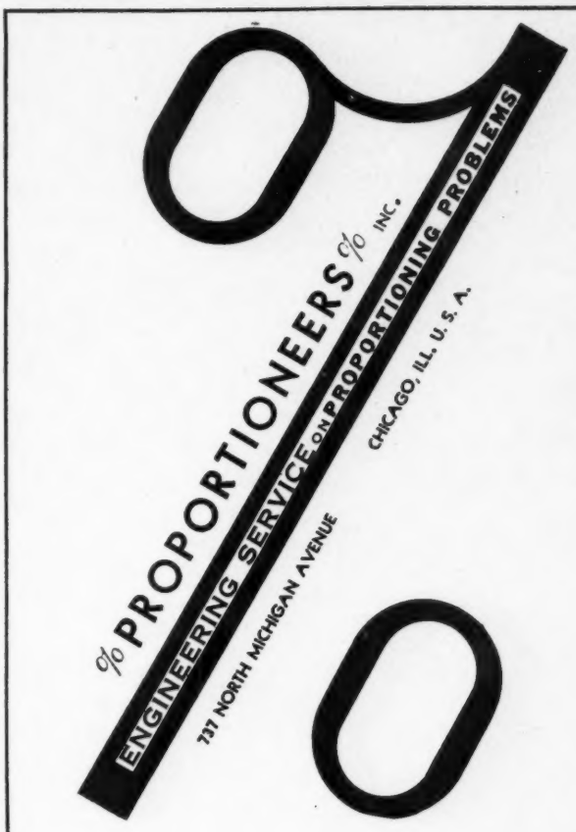

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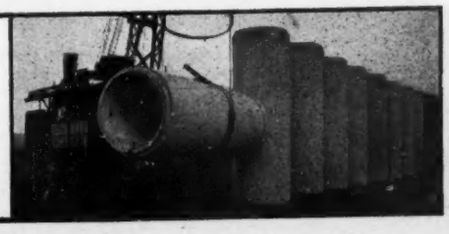

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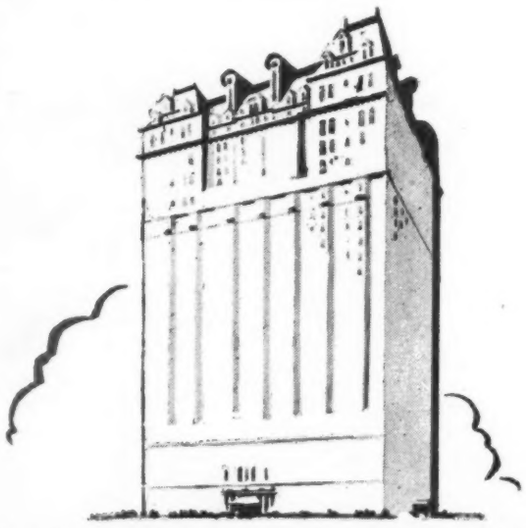

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